Landsat 7 Processing System (LPS)
Output Files
Data Format Control Book

March 15, 1996

GODDARD SPACE FLIGHT CENTER
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Abstract

This Data Format Control Book (DFCB) presents detailed data formats for the Level 0R files generated by the Landsat 7 Processing System (LPS). A Level 0R file set includes an image data file for each band of the Enhanced Thematic Mapper Plus (ETM+) instrument, a mirror scan correction data (MSCD) file, a payload correction data file (PCD), and a calibration data file. The LPS generates a Level 0R file set for each ETM+ data format: Format 1 and Format 2. The LPS also generates WRS scene level reduced size multi-browse images (files) from three chosen bands of the ETM+ Format 1 and one each metadata file for the two data formats received in a Landsat 7 subinterval. The LPS uses the Hierarchical Data Format (HDF) for storing these files in the LPS and for transferring to the Land Processes Distributed Active Archive Center LP DAAC) of the EOSDIS Core System (ECS).

This document is based on the requirements contained in the LPS DFCB and the LPS-LP DAAC interface control document (ICD). It will be baselined by the LPS Project for delivering Landsat 7 output data files to the LP DAAC.

Keywords: Data Format Control Document (DFCB)
Hierarchical Data Format (HDF)
Landsat 7 Processing System (LPS)
Land Processes Distributed Active Archive Center (LP DAAC)

Preface

This DFCB is controlled by the Landsat 7 Project office of the Mission Operations and Data Systems Division (MODSD) and may be updated by Document Change Notice (DCN) or revision. Comments and questions regarding this DFCB should be directed to:

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Acronym List

Section 1 — Introduction

1.1 Purpose

This data format control book (DFCB) defines detailed formats of the output (Level 0R, metadata and browse) files generated by the Landsat 7 Processing System (LPS). The LPS makes these files available on a Landsat 7 contact period basis for pick-up by the Landsat Processes Distributed Active Archive Center (LP DAAC).

The LPS output file formats described in this DFCB are based on the requirements contained in the LPS Functional and Processing Specification and the Interface Control Document between the EOSDIS Core System (ECS) and the Landsat 7 System.

1.2 Scope

This DFCB describes the data contents and HDF details for the LPS output files. The Functional, performance, operational and interface design details for the transfer of these files from LPS to the LP DAAC are contained in the ICD between the ECS and the Landsat 7 System. The contents of the LPS output files defined in this DFCB are based on the Landsat 7 ETM+ instrument and payload correction data (PCD) data details contained in the Landsat 7 Data Format Control Book, Volume IV - Wideband Data, the LPS F&PS, the ECS-LP DAAC ICD and the HDF guideline documents available from the ECS Project and/or the National Center for Supercomputing Applications (NCSA).

The file formats contained in this DFCB are applicable to the interface between the ECS LP DAAC and the LPS. This DFCB does not contain specific details on the file formats for the Landsat 7 Level 0R products generally requested by the Landsat 7 users. Detailed formats of the Level 0R products required by the Landsat 7 users are defined in a separate document, the Landsat 7 0R Distribution Product DFCB.

1.3 Intended User's

This document is intended as a supplements to LPS-LP DAAC ICD. Therefore, the LPS and the EOSDIS Projects are the primary users of this document. This document contains detailed information on the LPS output data file formats to allow users on both the LPS and EOSDIS project sides to proceed with independent development of the LPS and LP DAAC (systems).

This DFCB provides detailed information on the contents of the LPS Level 0R output files (Band, mirror scan correction data, payload correction data and Calibration data) and the metadata and browse image associated with these files. Both the LP DAAC and Landsat 7 users are interested in this data. The primary intention of the data formats contained in this DFCB is to support the development of the direct interface between the LPS and the LP DAAC. The Level 0R details contained in this DFCB may be adequate to serve the initial information need of the Landsat 7 users. Complete details on the Landsat t 7 Level 0R products desired by the Landsat 7 users/scientist community are defined in a separate Landsat 7 project document, the Landsat 7 0R Distribution Product DFCB.

Section 2 — Documentation

The following documents provide additional detailed and/or reference information regarding the LPS output files format. If there are conflicts between the listed documents and the contents of this DFCB, the contents of this DFCB shall be considered to be the superseding requirements.

2.1 Applicable Documents

1. NASA GSFC/MO&DSD, Landsat 7 Processing System (LPS) Functional and Performance Specification (F&PS), Revision 1, 560-8FPS/0194, July 28, 1995.

2. NASA GSFC, Interface Control Document (ICD) between the EOSDIS Core System (ECS) Landsat 7 System , Final, 209-CD-013-001, July 1995.

3. National Aeronautics and Space Administration (NASA) Goddard Space Flight Center (GSFC) Landsat 7 Detailed Mission Requirements, May 15, 1995.

4. Martin Marietta Astro Space (MMAS), Landsat 7 System Data Format Control Book (DFCB), Volume 4 - Wideband Data, 23007702, December 2, 1994

5. Hughes Applied Information Systems, Inc., HDF-EOS Primer for Version 1 EOSDIS, White Paper, 175-WK-001-001, April 1995.

6. Hughes Applied Information Systems, Inc., The HDF-EOS Swath Concept, White Paper, 170-WP-003-001, December 1995.

7. CCSDS Recommendation for Space Data System Standards, Parameter Value Language - A Tutorial, CCSDS 641.0-G-1, Green Book Issue 1, May 1992.

8. GSFC, EOSDIS Browse Delivery Package Description, Preliminary Draft, June 23, 1995.

9. GSFC, Landsat 7 0R Distribution Product Data Format Control Book, HDF Version, 1996

10. University of Illinois at Urbana-Champaign, National Center for Supercomputing Applications (NCSA), HDF User's Guide, June 1995.

11. University of Illinois at Urbana-Champaign, National Center for Supercomputing Applications (NCSA), HDF Reference Manual, February 1994.

12. Systems Engineering and Analysis Support (SEAS)/Loral Aerosys, HDF Format for MSCD Output Files: REVIEW VERSION, March 1996.

Section 3 — LPS Output Files Overview

3.1 Level 0R Files

The primary outputs of the LPS consist of Level 0R files, the metadata (file) and browse image files. The Level 0R files include ETM+ instrument band (image) data, mirror scan correction data (MSCD), payload correction data (PCD) and calibration data files. The band file(s) contain majority of the Level 0R processed science data collected from the Landsat 7 ETM+ instrument. A Level 0R band file contains reformatted, unrectified sub-interval data having a sequence of pixels which are spatially consistent with the ground coverage. The radiometric calibration, attitude, and ephemeris data, associated with the band file, are provided in the payload correction and calibration data files. The MSCD file provides additional scan related information for subsequent processing of the band file data to Level 1R. The LPS provides one set of Level 0R data and a metadata files for each ETM+ data format: Format 1 and Format 2. The browse image data files are provided for Format 1 data only. These data formats are associated with bands 1-6 and bands 6-8 of the ETM+ instrument, respectively.

3.1.1 Band Data File

Each band file contains the image data from a single band in a single sub-interval. The data is grouped by detectors, i.e., for a given major frame, detector 1 data is followed by detector 2 data, etc. Reverse scans are reversed. This data is nominally aligned using fixed and pre-determined integer-pixel values (provide alignment for band offset, even/odd detectors, and forward and reverse scans).

3.1.1 Mirror Scan Correction Data File

One MSCD file is created for each sub-interval. This file contains the Scan Line Data (SLD) extracted from the two minor frames following the End of Line Code (EOL) in each major frame of the sub-interval . The SLD includes the first half scan error (FHS ERR), the second half scan error (SHS ERR), and the Scan direction (SCN DIR) information. The time of the major frame corresponding to this data is appended. Data quality indicators associated with each major frame are also provided for each scan.

3.1.1 Payload Data File

One PCD file is created for each sub-interval. This file contains the PCD major frames received during a subinterval on a PCD cycle basis. PCD quality indicators are appended on major frame basis.

3.1.1 Calibration Data File

One file is generated for each sub-interval. This file contains all of the calibration data received on a major frame basis for a given sub-interval. This is the data received after the Scan Line Data (which follows the End of Line Code) and before the next major frame sync, as described in the Landsat 7 Wideband data DFCB. The data is grouped by detectors, i.e., for a given major frame, detector 1 data is followed by detector 2 data, etc. Reverse scans are reversed. The time of the major frame corresponding to this data is also appended.

3.2 Metadata File

One metadata file is created for each sub-interval. The metadata contains information on the Level 0R data provided in the sub-interval, the names of the Level 0R instrument data, calibration data, payload correction data, mirror scan correction data and browse image files associated with the sub-interval. Metadata also contains quality and accounting information on the return link wideband data used in generating the level 0R file(s). In addition, metadata includes quality and accounting information on received and processed PCD, and cloud cover assessment for the WRS scene contained in the sub-interval. The metadata is used by LP DAAC users to determine the sub-interval and/or WRS scene level quality of the Level 0R data stored in the LP DAAC archive before ordering it on a cost basis.

3.3 Multi-browse File

A multibrowse file is a reduced data volume file of the Level 0R band/image data which can be viewed on a scene basis to determine general ground area coverage and spatial relationships between ground area coverage and cloud coverage. The browse image data from 3 predetermined bands of the ETM+ Format 1 scene data are contained in a multi-band browse file. Each file contains a reduced resolution single scene of a full resolution scene data contained in the Level 0R band data files of a subinterval.

3.4 Hierarchical Data Format (HDF)

The EOSDIS project has selected the Hierarchical Data Format (HDF) for exchanging data with external systems. The EOSDIS Projects also uses the HDF for storing the received data in its active archives. The HDF allows a standard data structures for various types of data. Applicable Details on various data structures supported by the HDF are provided in Applicable Documents 5 and 10. Table 3-1 provides an overview of the HDF data structures used by LPS in generating the Level 0R output files.

Table 3-1: LPS Output Files HDF Data Structures

LPS File	ETM+ Format		Contents	HDF Structure
Band 1 Image Data	1		Binary	SDS
Band 2 Image Data	1		Binary	"
Band 3 Image Data	1		Binary	"
Band 4 Image Data	1		Binary	"
Band 5 Image Data	1		Binary	"
Band 6(L) Image Data	1		Binary	"
Band 6(H) Image Data		2	Binary	SDS
Band 7 Image Data		2	Binary	"
Band 8 Image Data		2	Binary	"
Mirror Scan Correction Data (MSCD)	1	2	Mixed	Vdata
Payload Correction Data	1	2	Mixed	Vdata
Calibration Data (all bands/format)	1	2	Binary	SDS
Metadata	1	2	ACII Text	P=V (PVL)
- Subinterval Level Metadata	1	2		
- WRS Scene Level Metadata	1	2		
- ACCA Results	1			
- Level 0R Q&A	1	2		
Browse Image Data	1		Binary	RIS24

3.5 File Naming Convention

The ECS and LPS projects have agreed to the following convention for naming the LPS output files:

File Name: L7XsssfnYYDOYHHuuv.xxx where:

Description	Remarks
L7 indicates the Landsat 7 mission	Fixed to "L7" for all files generated by LPS
X = 1, 2 or 3 for the L7 X-band data routed by LGS to an LPS String	Obtained by LPS operator from the Landsat 7 contact period schedule and the matrix switch connection information received from LGS. The LPS operator enters this information into each LPS string for each new contact period.
sss indicates data capture ground station, for example: sss = EDC at Sioux Falls, SD sss = ANC for Anchorage, Alaska (EDC uses 3 letter ground station name in a figure in the LPS Ops Concept)	A parameter entered by operator at LPS initialization and during LPS string switchover.
f indicates ETM+ data format: f = 1 for Format 1 data f = 2 for Format 2 data	Identifies the ETM+ Format 1 or 2 associated data contained in this file. The ETM+ format information is extracted from the PCD/Status data field of the first valid VCDU of the first major frame of the sub-interval reported in this file. A valid VCDU has no errors.
n indicates LPS processor number (1-9)	A parameter entered by LPS operator at LPS initialization.
YYDOYHH: indicates Landsat 7 contact period start date and time for this file, where: YY = Last two digit of year associated with a contact period DOY = Julian day of year (001 through 366) associated with contact period HH = hour of the contact period within a 24 hour day (00-23)	Data capture date and time obtained by LPS from the Landsat 7 contact period schedule received from LGS.

uu indicates a sub-interval number within this contact period (00- 99)	Generated by LPS during Level 0R processing.
v indicates dataset version number: v = 0 for the L0R processed data generated during the first processing run of a contact period v = 1 - 9 for reprocessed Level 0R data generated during subsequent processing runs of the same contact period	A reprocessing indicator used to distinguish Level 0R datasets (subinterval files) generated from a single contact period during multiple processing runs. The reprocessing information is tracked by LPS and/or entered by an operator during setup of a Level 0R processing operation.
xxx indicates an LPS File type: xxx = Bis for band files where: B indicates a "Band File", i indicates image band IDs 1 - 7, or "P" for Panchromatic (Pan) band 8, s indicates file segment number; s = 0 for a single segment file, s = 1 - 4 for Pan Band file segments xxx = MSD for an MSCD file xxx = PCD for a PCD file xxx = CAL for a Calibration File xxx = MTA for a Metadata File xxx = Rnn for Multi-Browse File where; nn = 01-99 indicates the WRS scene number identified in the metadata file.	The LPS Band 8 Level 0R processed output is broken into under 2 gigabytes (GB) segments to accomodate the HDF file size storage/data transfer limitations.

Section 4 — LPS Output Files Data Formats

4.1 Level 0R Files

This section contains details on the LPS Level 0R output file formats. The Level 0R files include:

- Band Files
- Mirror Scan Correction Data File (MSCD)
- Payload Correction Data File (PCD)
- Calibration Data File

The LPS generates two sets of Level 0R files, one for Format 1 data and another for Format 2 data. The LPS generates 6 Band files (Bands 1 - 6), one MSCD file, one PCD file and one calibration data file for the Format 1 data. For Format 2 data, the LPS generates 3 band files (Bands 6 - 8), one MSCD file, one PCD file and one calibration data file. The following section provide details on the contents of each Level 0R file.

4.1.1 Band Data File Format (HDF SDS)

4.1.1.1 Band Data File Description

The LPS generates two sets of band files for the ETM+ Format 1 and Format 2 Data. Bands 1 through 6 Level 0R files are generated for Format 1 data. Bands 6 through 8 are produced for Format 2 data. Each Band file is constructed using the HDF scientific data set (SDS) structure shown in Figures 4-1 and 4-2. Details on the HDF SDS definition of the LPS band files and their contents are provided in Tables 4-1 through 4-5.

Each band file consists of a single SDS containing an SDS array for the band/image data, and information on the band detector-pixel (X) and scan-line (Y) dimensions of the band SDS array. In addition, HDF predefined and user (LPS) defined attributes for the band file also included in the Band SDS. Band 8 image data is contained in four separate files, each containing an SDS for each segment of the band 8 image data. Scan-line and deter-pixels are defined as the two dimensions of a band data array. The spacecraft scan time information associated with the scan lines contained in a band data array is attached using the HDF user defined attributes.

4.1.1.2 Band Data File Volume(s)

The following assumptions and band data volume information are used in defining HDF SDS objects and attributes for the LPS band files.

1. ETM+ Scans per Scene:
   - Nominal: 355
   - Maximum: 375

2. Scan Data Lines (Maximum) per Scene:
   - Bands 1 - 5 and 7: 375 x 16 = 6,000
   - Band 6: 375 x 8 = 3,000
   - Band 8: 375 x 32 = 12,000

3. Subinterval Duration: 14 minutes (Maximum)
   (Longest possible contact period duration - worstcase)

4. Scene Duration: ~ 24 seconds

5. Number of Scenes per Subinterval: ~ 35
   (For the longest possible contact period with a single subinterval)

6. ETM+ Scans per Subinterval:
   Minimum: 355 x 35 = 12,425
   Maximum: 375 x 35 = 13,125

7. Scan Data Lines (Maximum) per Subinterval:
   - Bands 1 - 5 and 7: 6,000 x 35 = 210,000
   - Band 6: 3,000 x 35 = 105,000
   - Band 8: 12,000 x 35 = 420,000 (all 4 file segments)
   - Band 8: 12,000 x 35/4 = 105,000 (1 of 4 file segments)

8. Scan Data Line Lengths (Maximum):
   - Band 1 - 5 and 7: 6,330 + 270 = 6,600 Bytes
     (nominal with bumper wear + side margins)
   - Band 6: 6,600 / 2 = 3300 Bytes
   - Band 8: 6,600 x 2 = 13,200 Bytes

9. Subinterval Data Volume (Maximum):
   - Band 1 - 5 and 7: 210,000 x 6,600 = ~ 1.386 GB
   - Band 6: 105,000 x 3,300 = ~ 0.347 GB
   - Band 8: 420,000 x 13,200 = ~ 5.544 GB (all 4 segments)
   - Band 8 Segment: 5.544 / 4 =~ 1.386 GB (one segment)

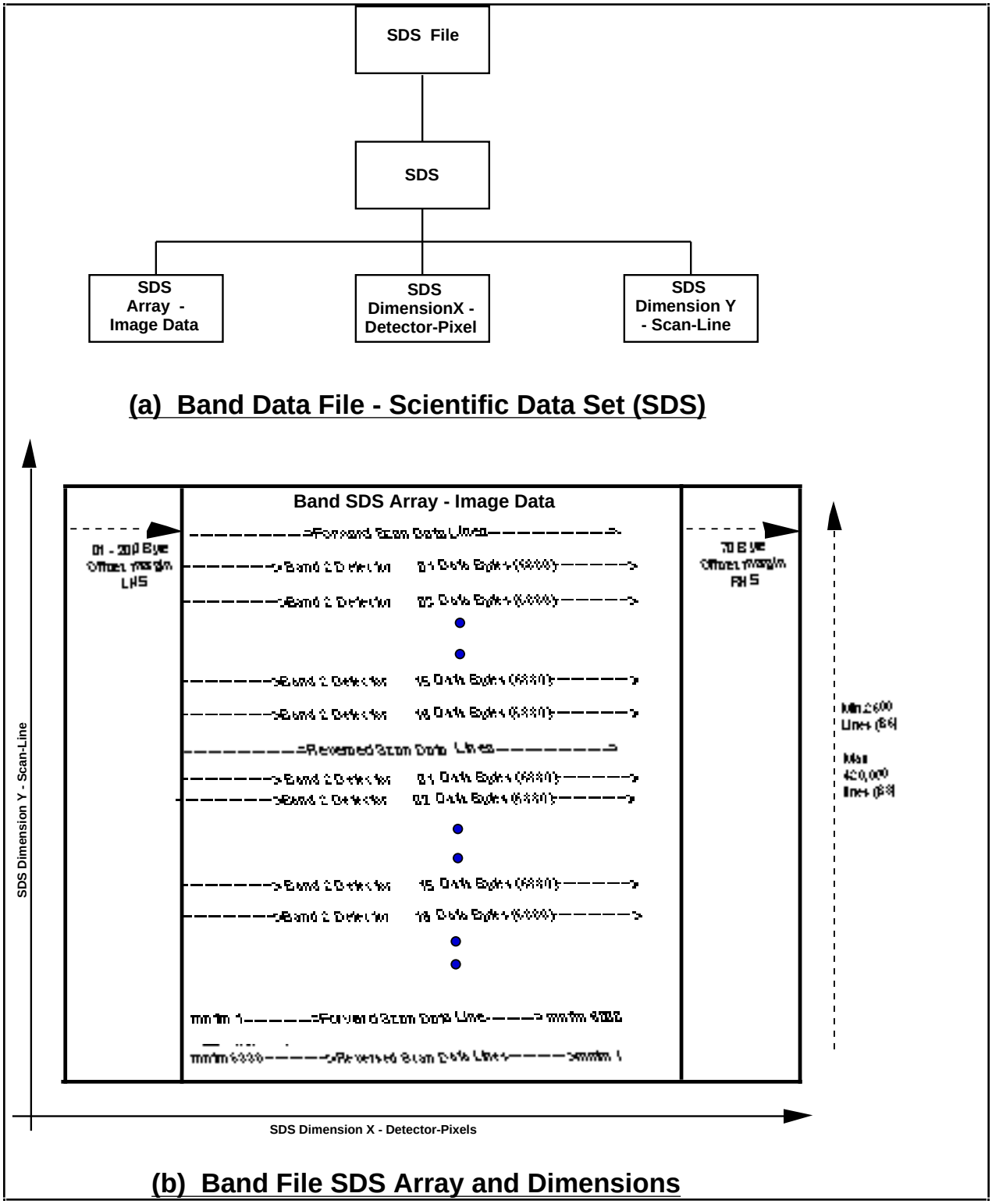


Figure 4-1: Band Data File - HDF SDS Structure

Table 4-1: Band Data File - HDF SDS Array Definition

HDF SDS File and Object Definitions	Remarks Ref: SDstart, SDcreate, SDwritedata
sds_file_name: "LXsssfnYYDOYHHuuv.xxx"	where; xxx = b10, b20, b30, b40, b50, b6L, b6H, b70, b81, b82, b83 or b84. **See Section 3.5 for LPS File naming convention.**
sds_name: "L7-band_ns"	where n = 1-8 and s = L or H for Format 1 or Format 2 Band 6 data, or s = 1-4 for Band 8 data segment SDS's
number_type: uint8	8-bit binary data
rank: 2	All band data is presented in two dimensions.
dimension_size (0): detector-pixels_x	where detector-pixels_x = 6600 for bands 1-5 and 7 = 3300 for bands 6 = 13200 for each Band 8 segment
dimension_size (1): scan_data_lines_y	where scan_data_lines_y = 1 - 210000 for bands 1-5 and 7 = 1 - 105000 for bands 6 = 1 - 105000 for each Band 8 segment
start (0) = 0 start (1) = 0	Start writing data from the first location in the first scan line
stride (0) = 1 stride (1) = 1	Write data in each location along the scan line Write data in each scan line (do not skip lines)
edge [0] = dimension [0] (minimum) edge [1] = dimension [1] (minimum)	To be selected by band SDS developer. A minimum slab size (edges) of one full scan line is suggested.

band_data_array_bns [x] [y]	where bn = bands 1-8 and s = L or H for Format 1 or Format 2 Band 6 data, or s = 1-4 for Band 8 data segment SDS's and where the x and y array ranges are determined by SDS dimensions (0) and (1), detector-pixels_x and scan_data_lines_y, respectively. Band data bytes are collected from a single detector to form a scan line. The scan line data LHS and RHS offsets indicate the actual start and end of a valid scan line after pixel alignment.

Table 4-2: Band Data File - HDF SDS Dimension Scale Definition(s)

Band SDS Dimension Scale Definition	Remarks HDF Ref: SDdimname, SDsetdimscale
dimension_x_name: "bns_detector_pixel"	where; bn = b1 - b8 for bands 1-8 s = 0 for bands 1 -5 & 7, s = L or H for band 6 s = 0 - 3 for band 8 segments (total 4 segments)
dimension_x_Count = detector_pixel_x	where detector_pixel_x = 1 - 6600 for bands 1-5 and 7 = 1 - 3300 for bands 6 = 1 - 13200 for each Band 8 segment
dimension_x_ number_type: uint32	32-bit binary
dimension_x_scale_values = detector_pixel [x]	where detector_pixel [x] = 1 - 6600 for bands 1-5 and 7 = 1 - 3300 for bands 6 = 1 - 13200 for each Band 8 Array of detector_pixel dimension scale values along a detector_pixel line (optional)
dimension_y_name: "bns_scanline"	where; bn = b1 - b8 for bands 1-8 s = 0 for bands 1 -5 & 7, s = L or H for band 6 s = 0 - 3 for band 8 segments (total 4 segments)
dimension_y_Count = scan_line_y	where scan_line_y = 1 - 210000 for bands 1-5 and 7 = 1 - 105000 for bands 6 = 1 - 105000 for each Band 8 segment
dimension_y_ number_type: uint32	32-bit binary
dimension_y_scale_values = scan_line [y]	where scan_line [y] = 1 - 210000 for bands 1-5 and 7 = 1 - 105000 for bands 6 = 1 - 105000 for each Band 8 segment (4 segments) Array of scanline dimension values along a scanline (optional)

Table 4-3: Band SDS Array - Predefined Attributes

Attribute Name (Reserved Label)	Number Type	Count	Value	Remarks HDF Ref: SDsetattr, SDsetdatastrs, SDsetcal, SDsetfillvalue,
sds_ array_label	char8		="Band ns" where n = 1 - 8 and s = L or H for band 6 s = 1-4 for band 8	Reserved Label: long_name Data from only a single band is included in an LPS Band file.
sds_ array_units	char8		="Pixel"	Reserved Label: units
sds_ array_format	char8		= "binary"	Reserved Label: format
sds_ array_coordinate_system	char8		= "Level 0R"	Reserved Label: cordsys
sds_ array_valid_range	uint8	2	min = 0 max = 255	Reserved Label: valid_range
sds_ array_fill_value	unit8	1	= 0	Reserved Label: _FillValue
sds_ array_cal_scale_factor	float64	1	= 1	Reserved Label: scale_factor
sds_ array_cal_scale_factor_error	float64	1	= 0	Reserved Label: scale_factor_err
sds_ array_cal_add_offset	float64	1	= 0	Reserved Label: add_off_set
sds_ array_cal_add_offset_error	float64	1	= 0	Reserved Label: add_offset_err
sds_ array_cal_number_type	int32	1	= uint8	Reserved Label: calibrated_nt

Table 4-4: Band SDS Dimension Scale - Predefined Attributes

Attribute Name (Reserved Label)	Number Type	Count	Value	Remarks HDF Ref: SDsetattr, SDsetdimstrs,
dimension_x_label	char8	6	"Pixles"	Reserved Label: "long_name"
dimension_x_units	char8	6	"Pixels"	Reserved Label: "units"
dimension_x_format	char8	-	not applicable	Reserved Label: "format"
dimension_y_label	char8	10	="Scan Lines"	Reserved Label: "long_name"
dimension_y_units	char8	10	="Scan Lines"	Reserved Label: "units"
dimension_y_format	char8	-	not applicable	Reserved Label: "format"

Table 4-5: Band SDS Array _ User Defined Attributes (by scan line)

Attribute Name	Number Type	Count	Value	Remarks HDF Ref: SDsetattr
scan_data_line_no	uint32	1	scan_data_line_no = SSSSSS where: SSSSSS = 1 - 210000 for Bands 1-5 & 7 = 1 - 105000 for Band 6 to = 1 - 420000 for Band 8 Note: The Band 8 scan line count is not reset between segments (1 - 4).	The Scan Line Counter is incremented for each Band-Detector line added to the subinterval band file. This counter is incremented once per ETM+ scan for Bands 1 - 5 and 7, once every two ETM+ scans for Band 6, and twice for each ETM+ scan for Band 8. The maximum line counts are shown for a 14 minute subinterval (35 scenes).
scan_no	int32	1	scan_no = 1 - 13125 The maximum scan count is based on a subinterval duration of 14 minutes for 35 scenes, each consisting of 375 (355+20) scans.	Provides a sequence counter for ETM+ scans (major frames) contained in a sub-interval . The ETM+ scan counter is incremented by one for each new scan, real or flywheeled, added to the sub-interval file.
scan_time	float64	1	scan_time in seconds since January 1, 1993 **(TBR - LPS software CCR to provide conversion)**	This time is a conversion of the scan_timecode (see below) in seconds.
scan_timecode	char8	23	Scan time of the form 'YY:ddd:hh:mm:ss.tttttt' where: YY: Last two digits of Julian Year ddd: Day (01 through 366) hh: hours (00 through 23) mm: minutes (00 through 59) ss: seconds (00 through 59) tttttt: milliseconds (0 - 9999999) The unit of the fractional seconds field (tttttt) is 1/10 microsecond.	The ETM+ scan start time extracted from the timecode minor frames of the ETM+ major frame/scan reported in this data record. A computed scan start time is provided if a valid time is not available from the time code minor frames.

scan_dir	char8	1	Scan direction character 'F' = Forward Scan 'R' = Reverse Scan	The ETM+ scan direction information interpolated from the Scan Line Data (SLD) minor frames of the first valid ETM+ major frame reported in this file. A valid ETM+ major frame has no errors.
detector-id	uint8	1	detector_id = dd where: dd= A single detector number in the range from 01 to 32 Band 1 - 5 & 7: 1-16 detectors Band 6: 1- 8 detectors Band 8: 1- 32 detectors	The band detector ID used in forming the scan data line. Data from each detector of a selected band is reported once in an incrementing for each scan, forward or reverse.
scan_data_line_ offset_lhs	unit8	1	= 1 -200 bytes The scan line data may be shifted to anywhere in the left-hand-side margin of the band data buffer after a westward pixel alignment.	The scan line data in each record of the band file is initially written with a predetermined size of byte off-set on the left and right of the designated scan line data area. These offsets are provided to accommodate scan line length growth due to ETM+ scanner bumper wear. During band-detector alignment, these offsets are also adjusted, without losing data, to indicate the resulting/adjusted start and stop bytes/pixel positions for the scan lines. (See also Figure 4-1)
scan_data_line_ offset_rhs	unit8	1	= 1 -70 bytes The scan line data may be shifted to anywhere in the right-hand-side margin of the band data buffer after a east ward pixel alignment.	Note - The right-hand-side margin may not as significant as the left_hand-side_margin.

4.1.2 MSCD File Format (HDF Vdata)

4.1.2.1 MSCD File Description

The LPS generates an MSCD file for each ETM+ format: Format 1 and Format 2. The LPS uses the HDF Vdata structure for generating an MSCD file. Table 4-6 defines the Vdata structure for the LPS MSCD file.

The MSCD file is organized by ETM+ scan. The spacecraft time associated with each ETM+ scan is provided in seconds since (**TBR)** since January 1, 1994. This time is also provided in the Julian day of year and time format.

Table 4-6: MSCD File - HDF Vdata Definition

Vdata Name: LXsssfnYYDOYHHuuv.xxx	where xxx = MSD for the MSCD file (also see Section 3.5 for details on LPS file naming convention).
Vdata Class: LPS_MSCD	
Interlace Type: FULL_INTERLACE	
Bytes Per Logical Record: 53	
Number of Records: One record per ETM+ scan (major frame)	

Field Name	Number Type	Order	Description	Remarks
scan_no	int32	1	Sub-interval scan counter = 0 - 12425 (For a maximum subinterval duration of 14 minutes for 35 scenes, each consisting of 355 scans).	Provides a sequence counter for the ETM+ scans (major frame) contained in a sub-interval . The ETM+ scan counter is incremented by one for each new scan, real or flywheeled, added to the sub-interval file. A minimum total of 355 scans (one scene) are reported in a subinterval file.
scan_time	float64	1	scan_time in seconds since January 1, 1993 **(TBR - LPS software CCR to provide conversion)**	This time is a conversion of the scan_timecode (see below) in seconds.
scan_timecode	char8	23	Scan line time of the form 'YY:ddd:hh:mm:ss.tttttt' where: YY: Last two digits of Julian Year ddd: Day (01 through 366) hh: hours (00 through 23) mm: minutes (00 through 59) ss: seconds (00 through 59) tttttt: milliseconds (0 - 9999999) The unit of the fractional seconds field (tttttt) is 1/10 microsecond.	The ETM+ scan start time extracted from the timecode minor frames of the ETM+ major frame/scan reported in this data record. A computed scan start time is provided if a valid time is not available from the time code minor frames.

scan_dir_vote	uint8	1	Scan direction majority vote quality 0 = all bits in all scan direction word groups are equal. 1 = at least one bit in the scan direction word groups is not equal to the other bits	
scan_dir	char8	1	Scan direction character 'F' = Forward Scan 'R' = Reverse Scan	The ETM+ scan direction information interpolated from the Scan Line Data (SLD) minor frames of the first valid ETM+ major frame reported in this file. A valid ETM+ major frame has no errors.
fhs_vote	uint8	1	FHS error majority vote quality 0 = all bits in each FHS Error word group are equal 1 = at least one bit in at least one FHS Error word group is not equal to the other bits in the group	
fhs_err	int16	1	First half scan error: 0 to FFF (hexadecimal) or; 0 to +/- 4096 (decimal)	The first half scan error (FHS ERR) interpolated from the Scan Line Data (SLD) minor frames of the first valid ETM+ major frame reported in this file. A valid ETM+ major frame has no errors.
shs_vote	uint8	1	SHS error majority vote quality 0 = all bits in each SHS Error word group are equal 1 = at least one bit in at least one SHS Error word group is not equal to the other bits in the group	
shs_err	int16	1	Second half scan error: 0 to FFF (hexadecimal) or; 0 to +/- 4096 (decimal)	The second half scan error (SHS ERR) interpolated from the Scan Line Data (SLD) field of the first valid ETM+ major frame reported in this file. A valid ETM+ major frame has no errors.

'N.B. ASCII values are enclosed in single quotes (e.g. '1' = ASCII one)

Field Name	Number Type	Order	Description	Remarks
gain_status	char8	6	'gggggg' where g's indicate positions 123456 for Format 1 data OR '678$$$' for Format 2 data where $$$ indicates 3 blank spaces. g = L in a band position indicates a Low gain g = H in a band position indicates a High gain.	For each band, the gain status is defined by the gain state value in the "PCD/Status Data" Field of the first error-free VCDU containing data for the scan.
gain_change	char8	6	'gggggg' where g's indicate positions 123456 for Format 1 data OR '678$$$' for Format 2 data where $$$ indicates 3 blank spaces. g = 0 in a band position indicates no gain change, i.e. the gain_status of the previous scan is equal to the gain_status of this scan. g = 1 in a band position indicates a gain change, i.e. the gain_status of the previous scan is not equal to the gain_status of this scan.	The first scan of the Vdata has gain_change = 0.
cadu_sync	uint8	1	Flag to indicate loss of CADU sync anywhere within the scan 0 = no loss, 1 = sync loss	

Field Name	Number Type	Order	Description	Remarks

scan_sync	uint8	1	Flag for valid sync for current major frame 0 = valid sync, 1 = flywheeled sync	Valid sync = the line sync code was correctly found and decoded as specified in the Landsat 7 DFCB. Flywheeled sync = the line sync code minor frame could not be correctly found and/or decoded as specified in the Landsat 7 DFCB. The presence of the Line Sync Code is "deduced" from correctly finding/decoding the Time Code minor frames of an ETM+ major frame.
timecode_flag	uint8	1	Valid timecode flag 0 = valid timecode, 1 = computed timecode	
eol_flag	uint8	1	Flag for valid end of line (EOL) pattern code 0 = valid pattern 1 = flywheeled EOL	
minf_faults	char8	1	An index (hexadecimal 0 through D) representing the number of minor frame faults (m) in the range: '0' = no faulty minor frames '1' = 1 ≤ m ≤2 '2' = 3≤ m ≤ 4 '3' = 5≤ m ≤ 8 '4' = 9 ≤ m ≤ 16 '5' = 17 ≤ m ≤ 32 '6' = 33 ≤ m ≤ 64 '7' = 65 ≤ m ≤ 128 '8' = 129 ≤ m ≤ 256 '9' = 257 ≤ m ≤ 512 'A' = 513 ≤ m≤ 1024 'B' = 1025 ≤ m ≤ 2048 'C' = 2049 ≤ m ≤ 4096 'D' = 4097 ≤ m ≤ **7436 (TBR)** 'E' = RESERVED 'F' = RESERVED	This quality index is computed by LPS. Without bumper wear, there are a nominal of 7402 minor frames in an ETM+ major frame. Accounting for 17 minor frames of bumper wear on each end of the scanner, there could be as many as 7436 minor frames in an ETM+ major frame **(TBR-L7 DFCB)**

4.1.3 PCD File Format (HDF Vdata)

4.1.3.1 PCD File Description

The LPS generates an PCD file for each ETM+ format: Format 1 and Format 2. The LPS uses the HDF Vdata structure for generating an PCD file. Table 4-7 defines the Vdata structure for the LPS PCD file.

The PCD file is organized by PCD major frames. The spacecraft time associated with each PCD major frame is provided in seconds since (**TBR)** since January 1, 1994. This time is also provided in the Julian day of year and time format.

Table 4-7: PCD File - HDF Vdata Definition

Vdata Name: LXsssfnYYDOYHHuuv.xxx	where xxx = PCD (also see Section 3.5 for details on LPS file naming convention).
Vdata Class: LPS_PCD	
Interlace Type: FULL_INTERLACE	
Bytes Per Logical Record: **16,481**	
Number of Records: One record per PCD major frame (4.096 spacecraft seconds)	

Field Name	Number Type	Order	Description	Remarks
cycle_count	uint8	1	PCD cycle number (00-99) There could be approximately 52 PCD cycles in a 14 minute long subinterval.	The PCD Cycle number associated with PCD major frame reported in this record of the PCD file. A PCD cycle consists of 4 consecutive PCD major frames. This number is incremented by 1 for each PCD major frame (0) (identified by spacecraft ID and timecode in words 72 of minor frames 96-102) received in the ETM+ sub-interval.
majf_count	uint8	1	PCD major frame counter value (001-999) There could be approximately 206 PCD major frames in a 14 minutes subinterval (PCD major frame time = 4.096 seconds).	The major frame counter value of the PCD major frame reported in this record of the subinterval PCD file. The PCD major frame number is incremented by one for each new PCD major frame added to this file.
majf_id	uint8	1	PCD major frame ID (0-3)	The PCD major frame ID is determined by the information contained in word 72, minor frames 96-103 of each PCD major frame contained in a PCD cycle. PCD major frame (0) is identified by the presence of spacecraft ID and timecode information in the word 72 locations. Other PCD major frames are identified by their ID numbers (1-3).

majf_time	fl64	1	PCD major frame time in seconds since January 1, 1993 **(TBR)**	This time is the PCD major frame time (majf_timecode; see next entry) converted by LPS to seconds since January 1, 1993.
majf_timecode	char8	19	PCD major frame time of the form 'YY:ddd:hh:mm:ss.ttttttt' where: YY: Last two digits of Julian Year ddd: Day (01 through 366) hh: hours (00 through 23) mm: minutes (00 through 59) ss: seconds (00 through 59) ttttttt: milliseconds (0 - 9999999) The unit of the fractional seconds field (ttttttt) is 1/10 microsecond.	For PCD major frame (0), the spacecraft time is extracted from PCD Major frame (0) of a PCD cycle. For PCD major frames 1-3, the spacecraft timecode is interpolated using the spacecraft time received for PCD major frame (0) of the associated PCD cycle.
bands_present	char8	6	Bands present indicator, a 123456 or 678$$$ if all bans are present for format 1 or format 2, respectively. A "-" indicates a missing band (e.g., '123-56' or "6-8$$$'. The $$$ indicate 3 blank spaces.	This information is extracted from the third PCD major frame, minor frame 32, word 72, bits 0 through 6.
etm_on	fl64	1	Time ETM+ was last turned on	This time is found in words 72 of minor frames 42-47 of PCD major frame (0). The ETM+ on time is a 48-bit extended precision floating point value in seconds from midnight of the first day of the current year. A maximum of 31,622,400 seconds are possible in a year. See Landsat 7 DFCB for details on the ETM+ On time conditions.

etm-off	fl64	1	Time ETM+ was last turned off	This time is found in words 72 of minor frames 84-89 of PCD major frame (0). The ETM+ on time is a 48-bit extended precision floating point value in seconds from midnight of the first day of the current year. A maximum of 31,622,400 seconds are possible in a year. See Landsat 7 DFCB for details on the ETM+ On time conditions.
fac_flag	uint8	1	Calibration door flag (0 = no activity, 1 = activity)	ETM+ Calibration Activity Status. This status is interpolated from "serial word P of the third PCD major frame, minor frame 83, word 72, bits 2 and 3.
majf_bytes	uint32	1	Total major frame PCD bytes received	The total number of PCD bytes received by LPS from VCDUs for this subinterval. Possible range: 0 - 30,504,804 for a 14 minute subinterval.
majf_lost_bytes	uint32	1	Total major frame PCD bytes missing	The total number of PCD bytes identified missing due to missing/erroneous VCDUs. Possible range: 0 - 30,504,804 for a 14 minute subinterval.
vcdu_errors	uint32	1	Number of erroneous VCDUs with PCD	Possible range: 0 - 7,626,201 for a 14 minute subinterval.
vote_errors	uint32	1	Total number of unpacked PCD bytes containing voting errors	Possible range: 0-3,389,422 for a 14 minute subinterval.
minf_sync_errors	uint32	1	Total number of PCD minor frame sync errors	Possible range: 0-27,136 for a 14 minute subinterval.
minf_count_errors	uint32	1	Total number of PCD minor frames received with incorrect minor frame counter values.	Possible range: 0-27,136 for a 14 minute subinterval.
minf_fill	uint32	1	Total number of filled PCD minor frames. Possible range: 0-27,136 for a 14 minute subinterval.	Total number of PCD minor frames received with erroneous data and filled by LPS with a known value.

majf_flag_errors	uint8	1	Number of PCD major frames with incorrect ID values	A maximum of 206 PCD major frames are possible during a 14 minute long sub-interval.
timecode_flag	uint8		Valid PCD timecode flag, where: 0 = valid timecode 1 = computed timecode	
majf_data	uint8	16384	Raw (TBD) PCD major frame consisting of 128 minor frames.	One full PCD major frame consisting of a maximum of 128 minor frames, each containing 128 8-bit words, is included in each PCD record. No PCD words, valid or not, are dropped by LPS. See Landsat 7 DFCB for details on PCD words. A summary of PCD locations by PCD cycle/major frame/word is provided in **the appendix.**

4.1.4 Calibration Data File Format (HDF SDS)

4.1.4.1 Calibration Data File Description

Figures 4-2 and 4-3 provide an overview of the HDF SDS structure for the Calibration file. The calibration file contains data from all bands from a single subinterval. The calibration data is organized in band sequential order. The calibration file for a Format 1 subinterval contains data from Bands 1 - 6, while the calibration file for a Format 2 subinterval contains data from Band 6 - 8. Each record in the calibration file contains an entire band-detector Cal. line data past the End-of-Line Code (EOL) and SLL/SD (FHS and SHS ERRs) fields of the ETM+ scan (major frame).

4.1.4.2 Calibration Data File Volume(s)

The following sizing assumptions are used to define the range of values included in the calibration file:

1. ETM+ Scans per Scene:
   - Nominal: 355
   - Maximum: 375

2. Scan Data Lines (Maximum) per Scene:
   - Bands 1 - 5 and 7: 375 x 16 = 6,000
   - Band 6: 375 x 8 = 3,000
   - Band 8: 375 x 32 = 12,000

3. Subinterval Duration: 14 minutes (Maximum)
   (Longest possible contact period duration - worstcase)

4. Scene Duration: ~ 24 seconds

5. Number of Scenes per Subinterval: ~ 35
   (For the longest possible contact period with a single subinterval)

6. ETM+ Scans per Subinterval:
   Minimum: 355 x 35 = 12,425
   Maximum: 375 x 35 = 13,125

7. Scan Data Lines (Maximum) per Subinterval:
   - Bands 1 - 5 and 7: 6,000 x 35 = 210,000
   - Band 6: 3,000 x 35 = 105,000
   - Band 8: 12,000 x 35 = 420,000 (all 4 file segments)

- Band 8: 12,000 x 35/4 = 105,000 (1 of 4 file segments)

8. Scan Data Line Lengths (Maximum):
   - Band 1 - 5 and 7: 960+240 = 1,200 Bytes (nominal + side margins)
   - Band 6: 1,200 / 2 = 600 Bytes
   - Band 8: 1,200 x 2 = 2,400 Bytes

9. Subinterval Data Volume (Maximum):
   - Band 1 - 5 and 7: 210,000 x 1,200 = ~ 0.252 GB
   - Band 6: 105,000 x 600 = 0.063 GB
   - Band 8: 420,000 x 2,400 = ~ 1.008 GB (in one segment)

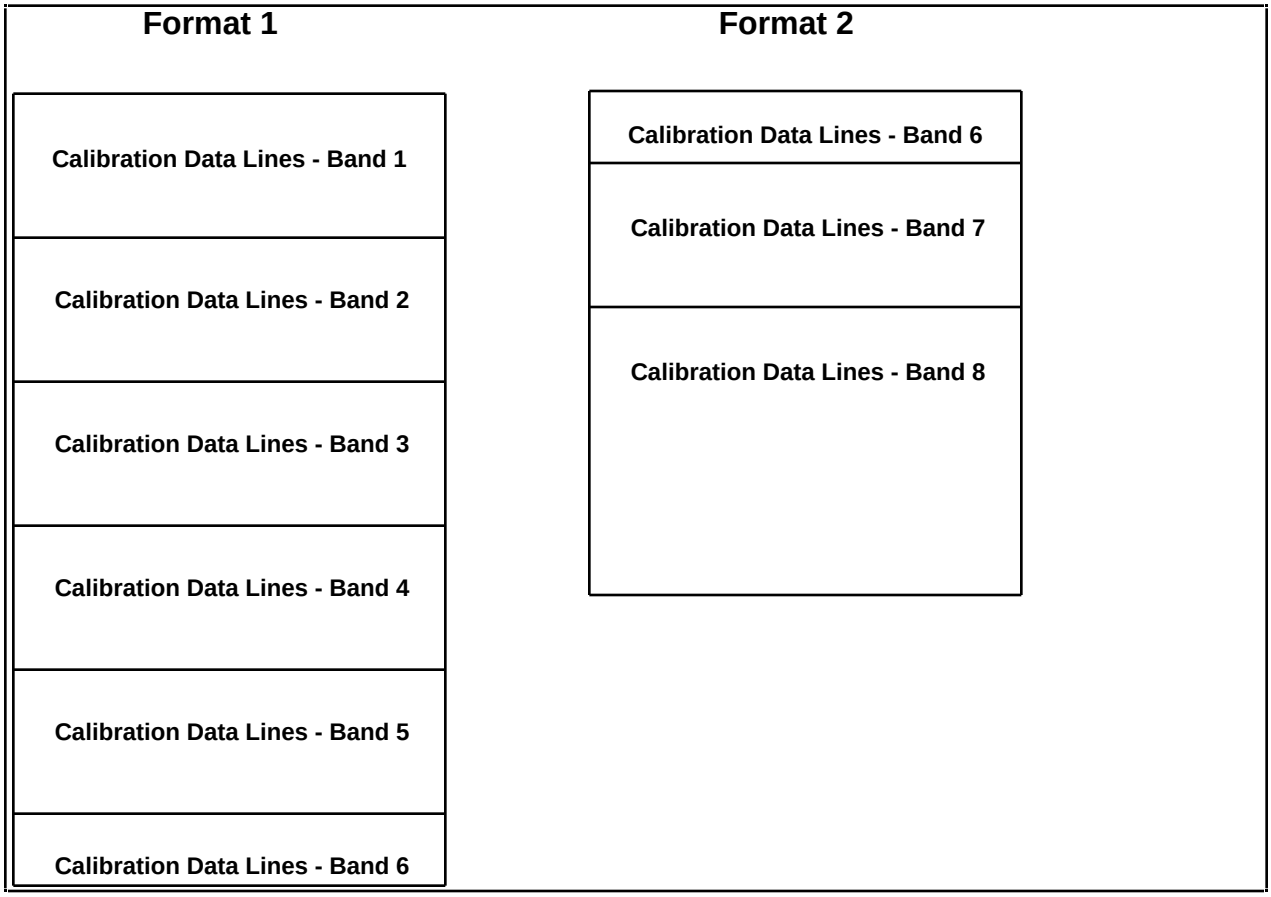


Figure 4-2: Calibration data Files - Band Data Organization

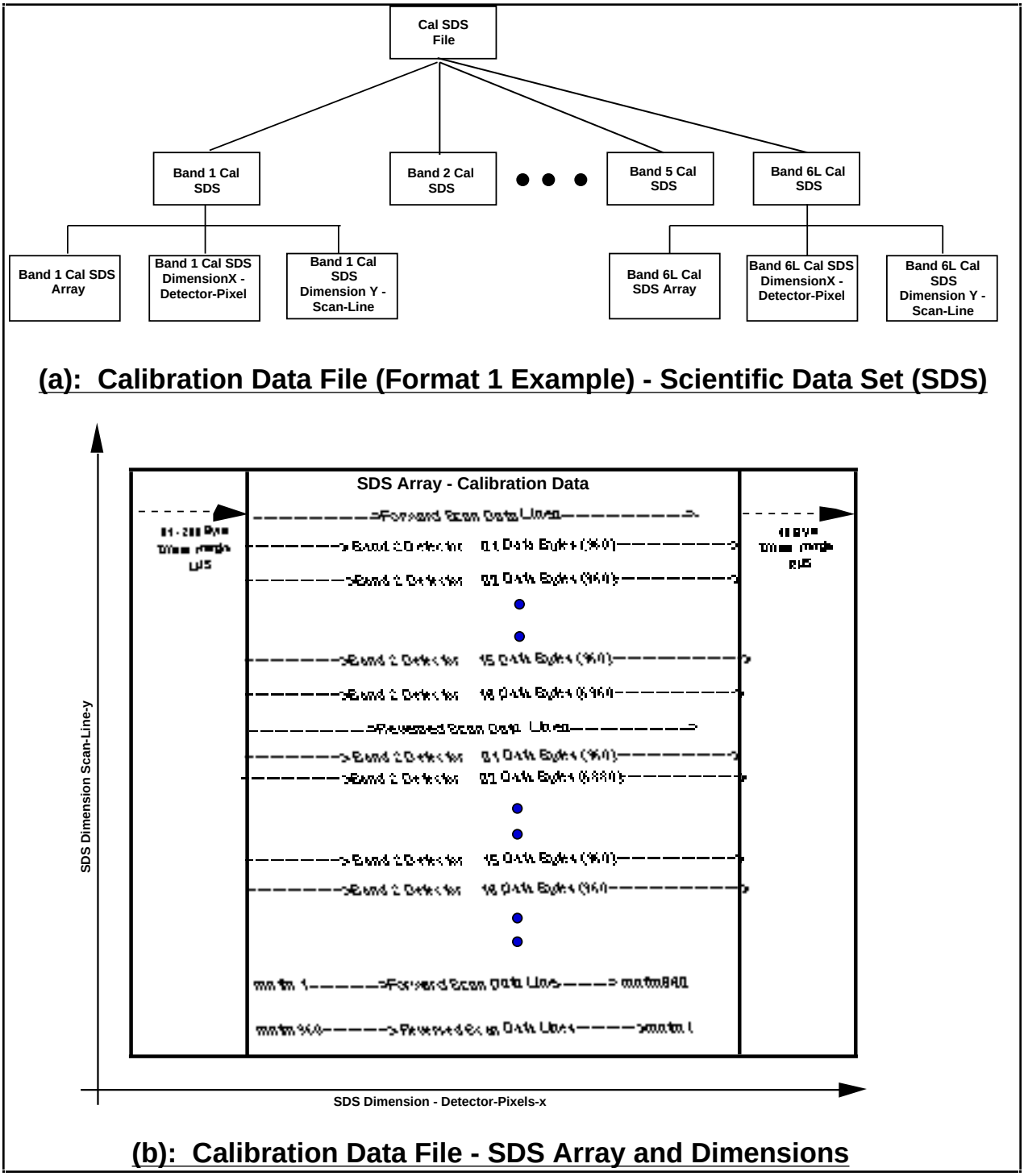


Figure 4-3: Calibration Data File - HDF SDS Structure

Table 4-8: Calibration Data File - HDF SDS Array Definition

HDF SDS File and Object Definitions	Remarks
sds_file_name: LXsssfnYYDOYHHuuv.xxx	where; xxx = "CAL" **See Section 3.5 for LPS File naming convention.**
sds_name: "L7_Format1_Cal"	
number_type: uint8	8-bit binary data
rank: 2	All band data is presented in two dimensions.
dimension_size (0): detector-pixels_x	where detector-pixels_x = 1200 for bands 1-5 and 7 = 600 for bands 6 = 2400 for Band 8
dimension_size (1): scan_data_lines_y	where scan_data_lines_y = 1 - 210000 for bands 1-5 and 7 = 1 - 105000 for bands 6 = 1 - 105000 for Band 8
start (0) = 0 start (1) = 0	Start writing data from the first location in the first scan line
Stride (0) = 1 Stride (1) = 1	Write data in each location along the scan line Write data in each scan line (do not skip lines)
Edge [0] = dimension [0] (minimum) Edge [1] = dimension [1] (minimum)	To be selected by band SDS developer. A minimum slab size (edges) of one full scan line is suggested.
cal_data_array_bns [x] [y]	where bn = bands 1-8 and s = L or H for Format 1 or Format 2 Band 6 data, or s = 1-4 for Band 8 data segment SDS's and where the x and y array ranges are determined by SDS dimensions (0) and (1), detector-pixels_x and scan_data_lines_y, respectively. Band data bytes collected from a single detector to form a cal data line. The cal data line data LHS and RHS offsets indicate the actual start and end of a valid cal data line after pixel alignment.

Table 4-9: Calibration Data File - HDF SDS Dimension Scale Definition(s)

Band SDS Dimension Scale Definition	Remarks HDF Ref: SDdimname, SDsetdimscale
dimension_x_name: "cal_bns_detector_pixel"	where; bn = b1 - b8 for bands 1-8 s = 0 for bands 1 -5, 7 and 8 segments s = L or H for band 6 segments
dimension_x_Count = cal_detector_pixel_x	where cal_detector_pixel_x = 1 - 1200 for bands 1-5 and 7 = 1 - 600 for bands 6 = 1 - 2400 for Band 8
dimension_x_ number_type: uint32	32-bit binary
dimension_x_scale_values = cal_detector_pixel [x]	where cal_detector_pixel [x] = 1 - 6600 for bands 1-5 and 7 = 1 - 3300 for bands 6 = 1 - 13200 for Band 8 Array of detector_pixel dimension scale values along a detector_pixel line (optional)
dimension_y_name: "cal_bns_scanline"	where; bn = b1 - b8 for bands 1-8 s = 0 for bands 1 -5, 7 and 8 segments s = L or H for band 6 segments
dimension_y_Count = cal_scan_line_y	where cal_scan_line_y = 1 - 210000 for bands 1-5 and 7 = 1 - 105000 for bands 6 = 1 - 105000 for Band 8
dimension_y_ number_type: uint32	32-bit binary
dimension_y_scale_values = cal_scan_line [y]	where cal_scan_line [y] = 1 - 210000 for bands 1-5 and 7 = 1 - 105000 for bands 6 = 1 - 105000 for Band Array of scanline dimension values along a scanline (optional)

Table 4-10: Cal Data SDS Array - Predefined Attributes

Attribute Name (Reserved Label)	Number Type	Count	Value	Remarks HDF Ref: SDsetattr, SDsetdatastrs, SDsetcal, SDsetfillvalue,
sds_ array_label	char8		="Cal Data" where n = 1 - 8	Reserved Label: long_name Data from only a single band is included in an LPS Band file.
sds_ array_units	char8		="Pixel"	Reserved Label: units
sds_ array_format	char8		= "uint8"	Reserved Label: format
sds_ array_coordinate_system	char8		= "Level 0R"	Reserved Label: cordsys
sds_ array_valid_range	uint8	2	min = 0 max = 255	Reserved Label: valid_range
sds_ array_fill_value	unit8	1	= 0	Reserved Label: _FillValue
sds_ array_cal_scale_factor	float64	1	= 1	Reserved Label: scale_factor
sds_ array_cal_scale_factor_error	float64	1	= 0	Reserved Label: scale_factor_err
sds_ array_cal_add_offset	float64	1	= 0	Reserved Label: add_off_set
sds_ array_cal_add_offset_error	float64	1	= 0	Reserved Label: add_offset_err
sds_ array_cal_number_type	int32	1	= uint8	Reserved Label: calibrated_nt

Table 4-11: Cal Data SDS Dimension Scale - Predefined Attributes

Attribute Name (Reserved Label)	Number Type	Count	Value	Remarks HDF Ref: SDsetattr, SDsetdimstrs,
cal_dimension_x_label	char8	6	"Pixles"	Reserved Label: "long_name"
cal_dimension_x_units	char8	6	"Pixels"	Reserved Label: "units"
cal_dimension_x_format	char8	-	not applicable	Reserved Label: "format"
cal_dimension_y_label	char8	10	="Scan Lines"	Reserved Label: "long_name"
cal_dimension_y_units	char8	10	="Scan Lines"	Reserved Label: "units"
cal_dimension_y_format	char8	-	not applicable	Reserved Label: "format"

Table 4-12: Cal Data SDS Array - User Defined Attributes (by scan line)

Attribute Name	Number Type	Count	Value	Remarks HDF Ref: SDsetattr

scan_data_line_no	uint32	1	scan_data_line_no = SSSSSS where: SSSSSS = 1 - 210000 for Bands 1-5 & 7 = 1 - 105000 for Band 6 to = 1 - 420000 for Band 8 Note: The Band 8 scan line count is not reset between segments (1 - 4).	The Cal Data Line Counter is incremented for each Band-Detector line added to the subinterval band file. This counter is incremented once per ETM+ scan for Bands 1 - 5 and 7, once every two ETM+ scans for Band 6, and twice for each ETM+ scan for Band 8. The maximum line counts are shown for a 14 minute subinterval (35 scenes).
scan_no	int32	1	scan_no = 1 - 13125 The maximum scan count is based on a subinterval duration of 14 minutes for 35 scenes, each consisting of 375 (355+20) scans.	Provides a sequence counter for ETM+ scans (major frames) contained in a sub-interval . The ETM+ scan counter is incremented by one for each new scan, real or flywheeled, added to the sub-interval file.
scan_time	float64	1	scan_time in seconds since January 1, 1993 **(TBR)**	This time is a conversion of the scan_timecode (see below) in seconds since January 1, 1993.
scan_timecode	char8	23	Scan time of the form 'YY:ddd:hh:mm:ss.tttttt' where: YY: Last two digits of Julian Year ddd: Day (01 through 366) hh: hours (00 through 23) mm: minutes (00 through 59) ss: seconds (00 through 59) tttttt: milliseconds (0 - 9999999) The unit of the fractional seconds field (tttttt) is 1/10 microsecond.	The ETM+ scan start time extracted from the timecode minor frames of the ETM+ major frame/scan reported in this data record. A computed scan start time is provided if a valid time is not available from the time code minor frames.
scan_dir	char8	1	Scan direction character 'F' = Forward Scan 'R' = Reverse Scan	The ETM+ scan direction information interpolated from the Scan Line Data (SLD) minor frames of the first valid ETM+ major frame reported in this file. A valid ETM+ major frame has no errors.

detector-id	uint8	1	detector_id = dd where: dd= A single detector number in the range from 01 to 32 Band 1 - 5 & 7: 1-16 detectors Band 6: 1- 8 detectors Band 8: 1- 32 detectors	The band detector ID used in forming the cal data line. Data from each detector of a selected band is reported once in an incrementing for each scan, forward or reverse.
cal_data_line_offset_lhs	unit8	1	= 1 -200 bytes The cal line data may be shifted to anywhere in the left-hand-side margin of the band data buffer after a westward pixel alignment.	The cal line data in each record of the band file is initially written with a predetermined size of byte off-set on the left and right of the designated cal line data area. These offsets are provided to accommodate cal line length growth due to ETM+ scanner bumper wear. During band-detector alignment, these offsets are also adjusted, without losing data, to indicate the resulting/adjusted start and stop bytes/pixel positions for the cal lines. (See also Figure 4-1)
cal_data_line_offset_rhs	unit8	1	= 1 -40 bytes The cal line data may be shifted to anywhere in the right-hand-side margin of the band data buffer after a east ward pixel alignment.	Note - The right-hand-side margin may not as significant as the left_hand-side_margin.

4.2 Metadata File Format (HDF PVL)

4.2.1 Metadata File Description

The LPS generates a metadata file for each ETM+ data format: Format 1 and Format 2. The LPS metadata file consists of two parts: a subinterval metadata segment and a WRS scene level metadata segment. The subinterval metadata segment contains reference information on the subinterval data source, the LPS processing resources used and the components constituting the Level 0R data files. The WRS scene level metadata segment provides information on one or more WRS scenes contained in the Level 0R processed data files. This metadata segments may contain WRS identification, geolocation references, cloud cover assessment, and image and PCD quality and accounting information for up to 35 WRS scenes received a 14 minute long Landsat 7 contact period. Section 4.2.2 contains exhibits of the Format and Format 2 metadata for LPS. Table 4-13 provides details on the LPS metadata items noted in the metadata exhibits.

4.2.2 Metadata File Format - HDF PVL Exhibits

The metadata file format conforms to the HDF PVL (parameter value language) structure. Details on the PVL file structure is provided in Applicable Document 2.1.6. Sections 4.2.2.1 and 4.2.2.2 illustrate the use of the HDF PVL for constructing the LPS Format 1 and Format 2 metadata files, respectively.

4.2.2.1 HDF PVL Example - Format 1 Metadata File

```
/* LPS Level 0R Subinterval Metadata File - Format 1 */

BEGIN_GROUP = SUBINTERVAL_METADATA_FILE1;

    /* Metadata File Identification */

        FILE_NAME = L71EDC139813513011.MTA;
        FILE__GEN_ DATE/TIME = 1998-05-15T13:30:25ZZ;
        FILE_VERSION_NO = 01;
        FILE_SOURCE_ID = USAEDC--LPS3;
        TOTAL_FILE_SEGMENTS = 0;
```

FILE_SEGMENT_NO = 0
SOFTWARE_VER_NO = 1.1;
IAS_PARAM_FILE_VER_NO = 1.3;

/* Subinterval Level Metadata */

BEGIN_GROUP = SUBINTERVAL_METADATA;
SPACECRAFT_ID = "Landsat 7";
ETM+_FORMAT = 1;
CONTACT_PERIOD_START_TIME = 1998-05-15T11:23:01;
CONTACT_PERIOD_STOP_TIME = 1998-05-15T11:37:10;
WRS_PATH = 0029;
STARTING_ROW = 0020;
ENDING_ROW = 0045;
SUBINTERVAL_START_TIME = 1998-05-15T11:25:01.350;
SUBINTERVAL_STOP_TIME = 1998-05-15T11:35:05.650;
TOTAL_ETM+_SCANS = 8853;
PCD_START_TIME = 1998-05-15T11:25:01.250;
PCD_STOP_TIME =1998-05-15T11:35:05.750;
TOTAL_ PCD_MAJOR_FRAMES = 101;
ETM+_LAST_ON_TIME = 1998-05-15T11:15:01.350;
ETM+_LAST_OFF_TIME = 1998-05-15T09:25:01.350;
BANDS_PRESENT = 123456;
TOTAL_WRS_SCENES = 25;
BAND_1_FILE_NAME = L71EDC139813513011.BB1;
BAND_2_FILE_NAME = L71EDC139813513011.BB2;
BAND_3_FILE_NAME = L71EDC139813513011.BB3;
BAND_4_FILE_NAME = L71EDC139813513011.BB4;
BAND_5_FILE_NAME = L71EDC139813513011.BB5;
BAND_6_FILE_NAME = L71EDC139813513011.BB6;
MSCD_FILE_NAME = L71EDC139813513011.MSD;
PCD_FILE_NAME = L71EDC139813513011.PCD;
CAL_FILE_NAME = L71EDC139813513011.CAL;
BROWSE_FILE_01 = L71EDC139813513011.R01;
BROWSE_FILE_02 = L71EDC139813513011.R02;
BROWSE_FILE_03 = L71EDC139813513011.R03;
BROWSE_FILE_04 = L71EDC139813513011.R04;
BROWSE_FILE_05 = L71EDC139813513011.R05;
BROWSE_FILE_06 = L71EDC139813513011.R06;
BROWSE_FILE_07 = L71EDC139813513011.R07;
BROWSE_FILE_08 = L71EDC139813513011.R08;
BROWSE_FILE_09 = L71EDC139813513011.R09;
BROWSE_FILE_10 = L71EDC139813513011.R10;
BROWSE_FILE_11 = L71EDC139813513011.R11;
BROWSE_FILE_12 = L71EDC139813513011.R12;
BROWSE_FILE_13 = L71EDC139813513011.R13;
BROWSE_FILE_14 = L71EDC139813513011.R14;
BROWSE_FILE_15 = L71EDC139813513011.R15;
BROWSE_FILE_16 = L71EDC139813513011.R16;

BROWSE_FILE_17 = L71EDC139813513011.R17;
BROWSE_FILE_18 = L71EDC139813513011.R18;
BROWSE_FILE_19 = L71EDC139813513011.R19;
BROWSE_FILE_20 = L71EDC139813513011.R20;
BROWSE_FILE_21 = L71EDC139813513011.R21;
BROWSE_FILE_22 = L71EDC139813513011.R22;
BROWSE_FILE_23 = L71EDC139813513011.R23;
BROWSE_FILE_24 = L71EDC139813513011.R24;
BROWSE_FILE_25 = L71EDC139813513011.R25;
END_GROUP = SUBINTERVAL_METADATA;

/* WRS Scene Metadata Repeated for each Scene in the data records */

BEGIN_GROUP = SCENE_METADATA_RECORDS;

BEGIN_GROUP = WRS_SCENE_01_METADATA;
WRS_SCENE_NO = 0001;
WRS_PATH = 0031; /* SIOUX FALL, SD!>
WRS_ROW = 0030; /* SIOUX FALL, SD!>
SCENE_CENTER_SCAN_NO = 000175;
SCENE_CENTER_SCAN_TIME = 1998-05-15T11:37:05.450;
SCENE_CENTER_LATTITUDE = +000042.1234567 <Degrees North>;
SCENE_CENTER_LONGITUDE = -000096.7654321 <Degrees West>;
HORIZONTAL_DISPLAY_SHIFT = 0275 <meters>;
UPPER_LEFT_CORNER_LAT = +000041.5432176 <Degrees North>;
UPPER_LEFT_CORNER_LONG = -000096.5432176 <Degrees West>;
UPPER_RIGHT_CORNER_LAT = +000041.4321765 <Degrees North>;
UPPER_RIGHT_CORNER_LONG = -000096.6543217 <Degrees West>;
LOWER_LEFT_CORNER_LAT = +000041.6543217 <Degrees North>;
LOWER_LEFT_CORNER_LONG = -000096.3543217 <Degrees West>;
LOWER_RIGHT_CORNER_LAT = +000041.3432176 <Degrees North>;
LOWER_RIGHT_CORNER_LONG = -000096.6543217 <Degrees West>;
Full_SCENE_CCA = 020 <percent>;
UPPER_LEFT_QUAD1_CCA = 001 <percent>;
UPPER_RIGHT_QUAD2_CCA = 009 <percent>;
LOWER_LEFT_QUAD3_CCA = 004 <percent>;
LOWER_RIGHT_QUAD4_CCA = 006 <percent>;
ACCA_ALGORITHM_ID_VER = "ACCA_11NOV95.ALG"
SUN_AZIMUTH_ANGLE = 020.1234567 <degrees>;
SUN_ELEVATION_ANGLE = 020.1234567 <degrees>;
BAND_GAINS = HHHHLL;
BAND_GAIN_CHANGES = NNNYNN;
FULL_APERTURE_CAL_FLAG = N;
PARTIAL_APERTURE_CAL_FLAG: D; /*Day*/
END_GROUP = WRS_SCENE_01_METADATA;

/*Scene Image Data Quality and Accounting Data */

BEGIN_GROUP = SCENE_01_ETM+_Q&A;
TOTAL_CADUS/VCDUS = 05439266;
FLYWHEEL_CADUS = 1<percent>;
R-S_ERR_VCDUS = 1<percent>;
BCH_CORRECTED_VCDUS = 1<percent>;
BCH_UNCORRECTED_VCDUS = 0<percent>;
BIT_ERR_RATE = 0.1e-6;
ETM+_TIMECODE_ERRORS = 0<percent>;
ENTIRELY_FILLED_SCANS = 0<percent>;
PARTIALLY_FILLED_SCANS = 1<percent>;
END_GROUP = SCENE_01_ETM+_Q&A;

/*Scene PCD Quality and Accounting Information */

BEGIN_GROUP = SCENE_01_PCD_Q&A;
PCD_WORDS_RECEIVED = 2470070;
PCD_BYTE_VOTING_ERR = 5<percent>;
TOTAL_PCD_MINOR_FRAMES = 19297;
PCD_MINOR_FRAME_ERR = 3<percent>;
FILLED_PCD_MINOR_FRMAES = 2<percent>;
FILLED_PCD_MAJOR_FRAMES = 1<percent>;
END_GROUP = SCENE_01_PCD_Q&A;

/Scene Processes PCD Quality and Accounting Info.*/

BEGIN_GROUP = PROCEESED_PCD_01_Q&A;
TOTAL_ATTITUDE_POINTS = 0037;
REJECTED_ATTITUDE_POINTS = 0002 <percent>;
MISSING_ATTITUDE_POINTS = 0001 <percent>;
TOTAL_EPHEMERIS__ POINTS = 0037;
REJECTED_EPHEMERIS_POINTS = 0000 <percent>;
MISSING_EPHEMERIS_POINTS = 0001 <percent>;
WRS_SCENES_NOT_CALCULATED = 0;
END_GROUP = PROCEESED_PCD_01_Q&A;

/* The WRS_SCENE_nn_METADATA GROUP is repeated untill nn > 25 */

END_GROUP = SCENE_METADATA_RECORDS;

END_GROUP = SUBINTERVAL_METADATA_FILE1;

4.2.2.2 HDF PVL Exhibit - Foramt 2 Metadata File

/* LPS Level 0R Subinterval Metadata File - Format 2 */

BEGIN_GROUP = SUBINTERVAL_METADATA_FILE2;

/* Metadata File Identification */

RECORD_NO = 000001,
FILE_NAME = L71EDC239813513011.MTA;
FILE__GEN_ DATE/TIME = 1998-05-15T13:30:25ZZ;
FILE_VERSION_NO = 01;
FILE_SOURCE_ID = USAEDC--LPS3;
TOTAL_FILE_SEGMENTS = 0;
FILE_SEGMENT_NO = 0
SOFTWARE_VER_NO = 1.1;
IAS_PARAM_FILE_VER_NO = 1.3;

/* Subinterval Level Metadata */

BEGIN_GROUP = SUBINTERVAL_METADATA;
SPACECRAFT_ID = "Landsat 7";
ETM+_FORMAT = 2;
CONTACT_START_TIME = 1998-05-15T11:23:01
CONTACT_STOP_TIME = 1998-05-15T11:37:10
WRS_PATH = 0029;
STARTING_ROW = 0020;
ENDING_ROW = 0045;
SUBINTERVAL_START_TIME = 1998-05-15T11:25:01.350;
SUBINTERVAL_STOP_TIME = 1998-05-15T11:35:05.650;
TOTAL_ETM+_SCANS = 8853;
PCD_START_TIME = 1998-05-15T11:25:01.250;
PCD_STOP_TIME =1998-05-15T11:35:05.750;
TOTAL_ PCD_MAJOR_FRAMES = 101;
ETM+_LAST_ON_TIME = 1998-05-15T11:15:01.350;
ETM+_LAST_OFF_TIME = 1998-05-15T09:25:01.350;
BANDS_PRESENT = 678---;
TOTAL_WRS_SCENES = 25;
BAND_6_FILE_NAME = L71EDC239813513011.BB6;
BAND_7_FILE_NAME = L71EDC239813513011.BB7;
BAND_8_FILE_NAME = L71EDC239813513011.BB8;
MSCD_FILE_NAME = L71EDC239813513011.MSD;
PCD_FILE_NAME = L71EDC239813513011.PCD;
CAL_FILE_NAME = L71EDC239813513011.CAL;
END_GROUP = SUBINTERVAL_METADATA;

/* WRS Scene-by-Scene Metadata for this Level 0R Subinterval */
/* Note: The WRS Scene Centers Correspond to Band 7 Scan Times */

BEGIN_GROUP = SCENE_METADATA_RECORDS;

BEGIN_GROUP = WRS_SCENE_01_METADATA;
WRS_SCENE_NO = 0001;
WRS_PATH = 0031; /* EDC at SIOUX FALL, SD!>
WRS_ROW = 0030; /* EDC at SIOUX FALL, SD!>
SCENE_CENTER_SCAN_NO = 000175;
SCENE_CENTER_SCAN_TIME = 1998-05-15T11:37:05.450;
SCENE_CENTER_LATTITUDE = +000042.1234567 <Degrees North>;
SCENE_CENTER_LONGITUDE = -000096.7654321 <Degrees West>;
HORIZONTAL_DISPLAY_SHIFT = 0275 <meters>;
UPPER_LEFT_CORNER_LAT = +000041.5432176 <Degrees North>;
UPPER_LEFT_CORNER_LONG = -000096.5432176 <Degrees West>;
UPPER_RIGHT_CORNER_LAT = +000041.4321765 <Degrees North>;
UPPER_RIGHT_CORNER_LONG = -000096.6543217 <Degrees West>;
LOWER_LEFT_CORNER_LAT = +000041.6543217 <Degrees North>;
LOWER_LEFT_CORNER_LONG = -000096.3543217 <Degrees West>;
LOWER_RIGHT_CORNER_LAT = +000041.3432176 <Degrees North>;
LOWER_RIGHT_CORNER_LONG = -000096.6543217 <Degrees West>;
SUN_AZIMUTH_ANGLE = 020.1234567 <degrees>;
SUN_ELEVATION_ANGLE = 020.1234567 <degrees>;
BAND_GAINS = HLL;
BAND_GAIN_CHANGES = YNN;
FULL_APERTURE_CAL_FLAG = Y;
PARTIAL_APERTURE_CAL_FLAG: N /*Night*/;
END_GROUP = WRS_SCENE_01_METADATA;

/*Scene Image Data Quality and Accounting Data */

BEGIN_GROUP = SCENE_01_ETM+_Q&A;
TOTAL_CADUS/VCDUS = 05439266;
FLYWHEEL_CADUS = 1<percent>;
R-S_ERR_VCDUS = 1<percent>;
BCH_CORRECTED_VCDUS = 1<percent>;
BCH_UNCORRECTED_VCDUS = 0<percent>;
BIT_ERR_RATE = 0.1e-6;
ETM+_TIMECODE_ERRORS = 0<percent>;
ENTIRELY_FILLED_SCANS = 0<percent>;
PARTIALLY_FILLED_SCANS = 1<percent>;
END_GROUP = SCENE_01_ETM+_Q&A;

/*Scene PCD Quality and Accounting Information */

BEGIN_GROUP = SCENE_01_PCD_Q&A;
PCD_WORDS_RECEIVED = 2470070;

PCD_BYTE_VOTING_ERR = 5<percent>;
TOTAL_PCD_MINOR_FRAMES = 19297;
PCD_MINOR_FRAME_ERR = 3<percent>;
FILLED_PCD_MINOR_FRMAES = 2<percent>;
FILLED_PCD_MAJOR_FRAMES = 1<percent>;
END_GROUP = SCENE_01_PCD_Q&A;

/Scene Processes PCD Quality and Accounting Info.*/

BEGIN_GROUP = PROCEESED_PCD_01_Q&A;
TOTAL_ATTITUDE_POINTS = 0037;
REJECTED_ATTITUDE_POINTS = 0002 <percent>;
MISSING_ATTITUDE_POINTS = 0001 <percent>;
TOTAL_EPHEMERIS__ POINTS = 0037;
REJECTED_EPHEMERIS_POINTS = 0000 <percent>;
MISSING_EPHEMERIS_POINTS = 0001 <percent>;
WRS_SCENES_NOT_CALCULATED = 0;
END_GROUP = PROCEESED_PCD_01_Q&A;

/* The WRS_SCENE_nn_METADATA GROUP is repeated untill nn > 25 */

END_GROUP = SCENE_METADATA_RECORDS;

END_GROUP = SUBINTERVAL_METADATA_FILE2;

Table 4-13: Metadata File Format - Prameter Value Details

Parameter Name	Type	Size (Byte)	Value Format and Range ($ sign indicates a blank space)	Parameter Description / Remarks
File Name	char8	22	= LXsssfnYYDOYHHuuv.xxx See Section 3.5 for details	
File Creation Date & Time	char8	16	YYYY:DDD:HH:MM:SS where: YY: Julian Year (1996 through 20) DDD: Day (01 through 366) HH: hours (00 through 23) MM: minutes (00 through 59) SS: seconds (00 through 59) The time is in the range from 00:001:00:00:00 to 99:365:23:59:59	LPS system date and time when this file was created. This time may vary from file to file within the same Level 0R file set. Note: The time format in CAPITAL letters indicates LPS Local generated system time is used.
File Version No.	char8	2	= RR: where RR = 0 indicates "not a reprocessed file" R = 01 through 99" indicates the file reprocess count value	Reprocessing indicator to distinguish this file from the Level 0R file generated earlier for the same sub-interval and provided to the LP DAAC. The reprocessing information may be tracked by LPS or entered by an operator during setup of the reprocess operation.
File Source ID	char8	12	CCCAAAAASSSn where: CCC indicates country name such as USA AAAAA indicates responsible agency such as "NOAA" in the case of LPS. SSS indicates the source ground station (e.g. EDC) and or a system such as the LPS. n indicates the source system string number (1 to 9) which generated the file	This field identifies the country, responsible agency and the source system which created this file.
Total File Segments	char8	1	S = 0 indicates that this file is a single file with no segments. S = 1 -4 indicates the total number of segments making this file.	This fields indicates the total number segments making this file is segmented. This field is used to indicate LPS Band 8 file segments.

File Segment No.	char8	1	N = 0 indicates that this file is a single file with no segments. N = 1 - 4 indicates the file segment number for this file. LPS allows from 1 to 4 segments for its Band 8 (Panchromatic Band) file.	Applicable only to the LPS Panchromatic (Band 8) file. This field allows LPS to segment a Band 8 subinterval into smaller segments to overcome system/data storage and transfer limitations.
Software Version No.	char8	4	V.R$: where V: Version Number (1 through 9) ".": period sign R: Release Number (1 through 9)	Version number of the software on the source system when this file was created.
IAS Parameter Version No.	char8	4	V.R$: where V: Version Number (1 through 9) ".": period sign R: Release Number (1 through 9)	The version No. of the IAS Parameter file used in generating this file.
Spacecraft Identification	char8	8	Landsat7	Spacecraft identification as reported in the SCID field (bits 2 through 9) of the first valid CADU of the first ETM+ (scan) reported in this file. A valid CADU/VCDU has no errors.
ETM+ Format	char8	2	Fn where: Fn = F1 for ETM+ Format 1 data Fn = F2 for ETM+ Format 2 data	This field identifies the ETM+ Format ,1 or 2, applicable for providing an allowable band data in this file. The ETM+ format information is extracted from the PCD/Status data field of the first valid VCDU of the first major frame of the sub-interval reported in this file. A valid VCDU has no errors.
Contact Period Start Time	char8	16	$YY:DDD:HH:MM:SS (See above for details)	The Start Date and Time when the contact period associated with this sub-interval was acquired from the Landsat 7 spacecraft via the LGS.
Contact Period Stop Time	char8	16	$YY:DDD:HH:MM:SS (See above for details)	The Stop Date and Time when the contact period associated with this sub-interval was acquired from the Landsat 7 spacecraft via the LGS.

WRS Path:	char8	3	PPP: 001 through 233	Reference WRS path number for all scenes included in this sub-interval.
Starting Row	Intgr	3	RRR: 001 through 248	The starting WRS row number (nominal) for the scene data included in this sub-interval.
Ending Row	Intgr	3	RRR: 001 through 248	The ending WRS Row Number (nominal) for the scene data included in this sub-interval.
Sub-interval Spacecraft Start Time	char8	20	$YY:ddd:hh:mm:ss.ttt with a range YY: Last two digits of Julian Year ddd: Day (01 through 31) hh: hours (00 through 23) mm: minutes (00 through 59) ss: seconds (00 through 59) ttt: milliseconds (000 through 999) The time is in the range from: 00:001:00:00:00.000 through 99:366:23:59:59.999	The spacecraft time extracted from the timecode minor frames of the first ETM+ major frame of the sub-interval reported in this file. (Note: The year information (Capitalized) is appended by LPS to the ETM+ timecode format.)
Sub-interval Spacecraft Stop Time	char8	20	$YY:ddd:hh:mm:ss.ttt with a range YY: Last two digits of Julian Year ddd: Day (01 through 31) hh: hours (00 through 23) mm: minutes (00 through 59) ss: seconds (00 through 59) ttt: milliseconds (000 through 999) The time is in the range from: 00:001:00:00:00.000 through 99:366:23:59:59.999	The spacecraft time extracted from the timecode minor frames of the last ETM+ major frame of the sub-interval reported in this file.
UT1_Correction	char8	4	= 0.nn milliseconds (**TBR)**	

Total ETM+ Scans (S)	char8	6	SSSSSS in the range of 000325 to 13,125	The total number of ETM+ scans reported in this subinterval file. A maximum of 13,125 scans can be received in a 14 minute subinterval (based on a maximum of 35 scenes, each consisting of at most 375 scans)
PCD Start Time	char8	16	ddd:hh:mm:ss.ttt (See above for details)	Time of the first PCD major frame in the PCD file associated with this sub-interval.
PCD Stop time	char8	16	ddd:hh:mm:ss.ttt (See above for details)	Time of the last PCD major frame in the PCD file associated with this sub-interval.
Total PCD Major Frames	char8	4	MMMM: in the range from 0000 through 9999	Total Number of PCD Major Frames present in the PCD file associated with this sub-interval. Approximately 212 major frames can be received by the LPS during a 14.1 minute long sub-interval.
ETM+ Last On Time	char8	20	$ddd:hh:mm:ss.ttt:ff with a range from 001:00:00:00.000:00 through 366:23:59:59.999.15 (ee format details above) Note: The PCD extracted time is in floating point format S39.8 where: S is the sign bit 39 indicates a 39 bit mantissa, and 8 indicates an 8 bit exponent. It needs to be converted to time format.	This field is as defined in the Landsat 7 DFCB. See PCD locator table in the appendix for locating this information in a PCD major frame. This information is in a 48-bit extended precision floating point value in seconds from midnight of the first day of the current year. A maximum of 31,622,400 seconds are possible in a year.
ETM+ Last Off Time	char8	20	$ddd:hh:mm:ss.ttt:ff with a range from 001:00:00:00.000:00 through 366:23:59:59.999.15 (ee format details above)	This field is as defined in the Landsat 7 DFCB. See PCD locator table in the appendix for locating this information in a PCD major frame. This information is in a 48-bit extended precision floating point value in seconds from midnight of the first day of the current year. A maximum of 31,622,400 seconds are possible in a year.

Bands Present	char8	6	nnnnnn: where: nnnnnn: 123456 indicates that all bands in Format 1 data are present OR nnnnnn: 678$$$ indicates that all bands in Format 2 data are present A missing band is shown by a "-" Band 8 is the Pan band.	This information is extracted from the third PCD major frame, minor frame 32, word 72, bits 0 through 6. All bands present in either Format 1 or Format 2 data are shown by their respective band numbers. A missing band is indicated by a "-" in its respective position.
Total WRS Scenes	char8	2	SS: in the range from 00 through 99	The total number of WRS scenes contained in this sub-interval. A maximum of 35 full scenes can be received by LPS in a 14.1 minute long sub-interval.

Band 1/6 File Name	char8	22	L7XsssfnYYDOYHHuuv.xxx where: L7 indicates the Landsat 7 mission X = 1, 2 or 3 for the L7 X-band used to downlink data to the LGS sss indicates ground station source indicator, for example: sss = EDC at Sioux Falls, SD sss = ANC for Anchorage, Alaska (EDC uses 3 letter ground station name in a figure in the LPS Ops Concept) f indicates ETM+ data format: f = 1 for Format 1 data f = 2 for Format 2 data n indicates LPS processor number (1-9) YYDOYHH: indicates Landsat 7 contact period receive date, time, where: YY = Last two digit of year associated with a contact period DOY = day of year (001 through 366) associated with contact period HH = hour of the contact period within a 24 hour day (00-23) uu indicates a Sub-interval number within this contact period (00- 99) v indicates dataset version number: v = 0 for original v = 1 - 9 for reprocessed data. xxx indicates an LPS File type; the following file types are used in LPS: xxx = Bis for band files where: B indicates a "Band File", i indicates the :Band ID "1 through 7" for image bands 1 - 7, and "P" for the Panchromatic band 8, s indicates the file segment number s = 0 for "one segment file only", s = 1 - 4 for Pan Band file segments	Image Band 1 File Name (if Format 1 data) associated with this sub-interval. OR Image Band 6 File Name (if Format 2 data) associated with this sub-interval.

Band 1/6 File Name (contd.)	char8		xxx = MSD for an MSCD file xxx = PCD for a PCD file xxx = CAL for a Calibration File xxx = MTA for a Metadata File xxx = Rnn for Multi-Browse File where nn (01-99) indicates the WRS scene number identified in the metadata file. xxx indicates an LPS File type; the following file types are used in LPS: xxx = Bis for band files where: B indicates a "Band File", i indicates the :Band ID "1 through 7" for image bands 1 - 7, and "P" for the Panchromatic band 8, s indicates the file segment number s = 0 for "one segment file only", s = 1 - 4 for Pan Band file segments xxx = MSD for an MSCD file xxx = PCD for a PCD file xxx = CAL for a Calibration File xxx = MTA for a Metadata File xxx = Rnn for Multi-Browse File where nn (01-99) indicates the WRS scene number identified in the metadata file.	
Band 2/7 File Name	char8	22	L7XsssfnYYDOYHHuuv.xxx (same as defined above)	Image Band 2 File Name (if Format 1 data) associated with this sub-interval. OR Image Band 7 File Name (if Format 2 data) associated with this sub-interval.
Band 3/8 File Name	char8	22	L7XsssfnYYDOYHHuuv.xxx (same as defined above)	Image Band 3 File Name (if Format 1 data) associated with this sub-interval. OR Image Band 8 File Name (if Format 2 data) associated with this sub-interval.

Band 4 File Name	char8	22	L7XsssfnYYDOYHHuuv.xxx (same as defined above)	Image Band 4 File Name (Format 1 only) associated with this sub-interval. No band file name/record is included in a Format 2 file.
Band 5 File Name	char8	22	L7XsssfnYYDOYHHuuv.xxx (same as defined above)	Image Band 5 File Name (Format 1 only) associated with this sub-interval. No band file name/record is included in a Format 2 file.
Band 6 File Name	char8	22	L7XsssfnYYDOYHHuuv.xxx (same as defined above)	Image Band 6 File Name (Format 1 only) associated with this sub-interval. No band file name/record is included in a Format 2 file.
MSCD File Name	char8	22	L7XsssfnYYDOYHHuuv.xxx same as defined above. xxx = MSD for an MSCD file	Name of the Mirror Scan Correction Data (MSCD) File associated with this sub-interval.
PCD File Name	char8	22	L7XsssfnYYDOYHHuuv.xxx same as defined above. xxx = PCD for a PCD file	Name of the Payload Correction Data (PCD) File associated with this sub-interval.
Calibration File Name	char8	22	L7XsssfnYYDOYHHuuv.xxx same as defined above. xxx = CAL for a Calibration File	Name of the Calibration File (Format 1 or Format 2) associated with this sub-interval.
Browse File Name(s)	char8	22	L7XsssfnYYDOYHHuuv.xxx same as defined above. xxx = Rnn for Multi-Browse File where nn (01-99) indicates the WRS scene number identified in the metadata file.	Names of all Multi-Browse File (Format 1 only) associated with this sub-interval. This filed is repeated for each WRS scene included in this subinterval. A maximum of 35 WRS scenes in subinterval are possible.
Scene Metadata				**The following Parameters Values are repeated for each WRS scene included in the sub-interval.**
WRS Scene Number	char8	3	SSSS: in the range from 0001 through 0099	WRS Scene Number SSSS in this sub-interval.
WRS Path	char8	3	PPP: 0001 through 0233	WRS Scene Path Number
WRS Row	char8	3	RRR: 0001 through 0248	WRS Scene Row Number

Scene Center Scan Number	char8	6	nnnnnn: 000001 through 999999	The scan number in this sub-interval which is found to be closest to a nominal WRS Scene Center for this scene. The scan number, in a 14 minute long sub-interval can be as high as 13,125.
Scene Center Scan Time	char8	18	YY:DDD:hh:mm:ss.ttt (See above for details)	WRS Scene Center Scan Time
Scene Center Latitude	char8	16	STTTTTTT.TTTTTTT in the range from 0.0 through 90.0 degrees S: + defines latitude to the North S: - defines latitude to the south	WRS Scene Center Latitude - Nominal from WRS Map
Scene Center Longitude	char8	16	SNNNNNNN.NNNNNNN in the range from 0.0 through 180.0 degrees S: + defines longitude to the East S: - defines longitude to the West	WRS Scene Center Longitude - Nominal from WRS Map
Horizontal Display Shift	char8	4	MMMM meters in 0001 - 9999 range	WRS Scene Center Horizontal Display Shift
Upper Left Corner Latitude	char8	16	STTTTTTT.TTTTTTT (see above for definition)	WRS Scene Upper Left Corner Latitude
Upper Left Corner Longitude	char8	16	SNNNNNNN.NNNNNNN (see above for definition)	WRS Scene Upper Left Corner Longitude - Nominal Value (TBR)
Upper Right Corner Latitude	char8	16	STTTTTTT.TTTTTTT (see above for definition)	WRS Scene Upper Right Corner Latitude - Nominal Value (TBR)
Upper Right Corner Longitude	char8	16	SNNNNNNN.NNNNNNN (see above for definition)	WRS Scene Upper Right Corner Longitude - Nominal Value (TBR)
Lower Left Corner Latitude	char8	16	STTTTTTT.TTTTTTT (see above for definition)	WRS Scene Lower Left Corner Latitude - Nominal Value (TBR)
Lower Left Corner Longitude	char8	16	SNNNNNNN.NNNNNNN (see above for definition)	WRS Scene Lower Left Corner Longitude - Nominal Value (TBR)

Lower Right Corner Latitude	char8	16	STTTTTTT.TTTTTTT (see above for definition)	WRS Scene Lower Right Corner Latitude - Nominal Value (TBR)
Lower Right Corner Longitude	char8	16	STTTTTTT.TTTTTTT (see above for definition)	WRS Scene Lower Right Corner Longitude - Nominal Value (TBR)
Scene CCA	char8	3	cccc: 0% to 100% cloud cover	Cloud Cover Assessment (full Scene)
Quad 1 CCA	char8	3	cccc: 0% to 100% cloud cover	Cloud Cover Assessment (Upper Left Quadrant)
Quad 2 CCA	char8	3	cccc: 0% to 100% cloud cover	Cloud Cover Assessment (Upper Right Quadrant)
Quad 3 CCA	char8	3	cccc: 0% to 100% cloud cover	Cloud Cover Assessment (Lower Left Quadrant)
Quad 4 CCA	char8	3	cccc: 0% to 100% cloud cover	Cloud Cover Assessment (Lower Right Quadrant)
ACCA Algorithm ID	char8	12	AAAAAAAAAAAA TBR - Algorithm ID/version No.	Identifies the ACCA algorithm name/version number used by LPS in assessing the cloud cover assessment reported for this scene.
Sun Azimuth Angle	char8	12	SNNN.NNNNNNN in the range from 0.0 through 180.0 degrees S: + or -	Sun Azimuth Angle **(TBR)**
Sun Elevation Angle	char8	12	SNNN.NNNNNNN in the range from 0.0 through 180.0 degrees S: + or -	Sun Elevation Angle **(TBR)**
Band Gains	char8	6	gggggg: where g's indicate band positions 123456 for Format 1 data OR 678$$$ for Format 2 data where: $$$ indicates 3 blanks spaces. g = L in a band position indicates a Low gain g = H in a band position indicates a High gain	Band Gains at the start of a WRS Scene. The Band gains information is extracted by LPS from Words 7 and 8 of the PCD/Status data Field contained in the VCDU.

Band Gain Changes	char8	6	gggggg: where g's indicate band positions 123456 for Format 1 data OR 678$$$ for Format 2 data where: $$$ indicates 3 blanks spaces. g = 0 in a band position indicates no change in gain during this scene g = 1 in a band position indicates a change in gain during this scene.	Band Gain Change Flags generated by LPS.
Full Aperture Cal. Activity Flag	char8	1	F = 0 or 1 0: indicates no Full calibration activity during this scene 1: indicates Full calibration activity	This field indicates the ETM+ Full Calibration Activity during this scene. The calibration door activity flag is interpolated from "serial word P of the third PCD major frame, minor frame 83, word 72, bits 2 and 3.
Day/Night Flag	char8	1	= D for Day Flag True = N for Night Flag True	This field indicates the ETM+ Partial Calibration Activity during this scene. This flag indicates the day/night condition for the current scene. LPS determines the day/night (Partial Aperture Cal. Activity) condition by comparing the Sun Azimuth and Elevation values against known angle values.
Image Q&A Data				**The following Parameter Values are repeated for each WRS scene included in this sub-interval.**
CADUs/VCDUs Received	char8	8	cccccccc: in the range from 00000001 through 99999999	Total Number of CADUs/VCDUs contained in this sub-interval. The largest size sub-interval if received by LPS, will contain approximately 7,626,201 CADUs/VCDUs for a longest size contact period of 14 minutes.
Fly-wheeled CADUs	char8	4	FFF%: in the range from 000% - 100%	The percent of CADUs fly-wheeled due to sync errors.
R-S Error VCDUs	char8	4	RRR%: in the range from 000% - 100%	The percent of VCDUs with Reed-Solomon error corrected in the header field.

BCH Corrected VCDUs	char8	4	CCC%: in the range from 000% - 100%	The percent of VCDUs with BCH errors corrected for up to 3 bits in their mission data fields.
BCH Uncorrected VCDUs	char8	4	UUU%: in the range from 000% - 100%	The total number of VCDUs containing uncorrected BCH errors (bits) in their mission data fields.
Bit Error Rate	char8	4	BBBB: in the range from 0000 - 9999 BBBB = **** indicates counter overflow (BBBB > 9999).	The average number of bit errors found in blocks of 100,000 bits aggregated over the length of this sub-interval. This BER is calculated using bit errors detected (corrected or not) during CRC and BCH checks of the input VCDUs. An input data bit error rate of 1 in 100,000 or less is considered acceptable.
ETM+ Timecode Errors	char8	4	TTT%: in the range from 000% - 100%	The percent of ETM+ Scans (major frames) detected with errors in their time code fields during processing of this sub-interval. There are approximately 11755 major frames in a 14 minute long contact period (the largest possible sub-interval).
Entirely Filled Scans	char8	4	FFF%: in the range from 000% - 100%	The percent of ETM+ major frames in this sub-interval which were entirely filled using a pre-determined fill data pattern.
Partially Filled Scans	char8	4	PPP%: in the range from 000% - 100%	The percent of ETM+ major frames in this sub-interval which were partially filled using a pre-determined fill data pattern.
PCD Q&A Data				**The following Parameter Values are repeated for each WRS scene included in the sub-interval.**

PCD Words Received	char8	8	wwwwwwww in the range from 00000000 to 3500000	The total number of PCD words, extracted from the unpacked PCD bytes (one sync byte, 3 repeated data bytes and a fill byte), received during this subinterval. Approximately 3,470,000 PCD bytes can be received by LPS during a 14.1 minute long sub-interval.
PCD Byte Voting Errors	char8	4	VVV%: in the range from 000% - 100%	The percent of PCD Word which encountered byte voting errors during packing.
Total PCD Minor Frames	char8	6	mmmmmm in the range 000000 to 30000	The total number of PCD minor frames constructed during this subinterval. Approximately 27,072 PCD minor frames can be received by LPS during a 14.1 minute long sub-interval.
PCD Minor Frame Errors	char8	4	SSS%: in the range from 000% - 100%	The percent of PCD minor frames which encountered sync errors during their construction.
Filled PCD Minor Frames	char8	4	NNN%: in the range from 000% - 100%	The percent of PCD minor frames which required a data fill during their construction.
Filled PCD Major Frames	char8	4	JJJ%: in the range from 000% - 100%	The total number of PCD major frames which required a data fill during their construction. Approximately 212 major frames can be received by the LPS during a 14.1 minute long sub-interval.
Processed PCD Q&A Data				**The following Parameter are repeated for each WRS scene included in the sub-interval.**
Attitude Data Points	char8	4	AAAA: in the range from 0000 through 9999	The total number of spacecraft attitude data points (quaternations) received and processed from the PCD of this subinterval. Approximately 848 spacecraft attitude data points can be received during a 14.1 minute long sub-interval.

Rejected Attitude Data	char8	4	AAA%: in the range from 000% - 100%	The percent of spacecraft attitude data points (quaternations) found to fail the PCD quality checks. The rejected data points are flagged and included in the PCD file associated with this sub-interval.
Missing Attitude Data	char8	4	MMM%: in the range from 000% - 100%	The percent of spacecraft attitude data points (quaternations) found missing during PCD quality checks. The missing data points are flagged and included in the PCD file associated with this sub-interval.
Ephemeris Data Points	char8	4	EEEE: in the range from 0000 through 9999	The total number of ephemeris data points received and processed from the PCD of this sub-interval. Approximately 212 ephemeris data points can be received during a 14.1 minute long sub-interval.
Rejected Ephemeris Data	char8	4	EEE%: in the range from 000% - 100%	The percent of spacecraft ephemeris data points found to fail LPS PCD quality checks. The rejected data points are flagged and included in the PCD file associated with this sub-interval.
Missing Ephemeris Data	char8	4	MMM%: in the range from 000% - 100%	The percent of spacecraft ephemeris data points found missing during PCD quality checks. The missing data points are flagged and included in the PCD file associated with this sub-interval.
WRS Scenes not Calculated	char8	2	SS: in the range from 00 through 99 **(TBR - not an F&PS requirement)**	This count indicates the number of WRS scenes in this subinterval which could not be calculated because not enough data points (attitude and ephemeris) were available. A minimum of 6 consecutive points are required to calculate a WRS scene center.

4.3 Multibrowse File Format (HDF RIS24)

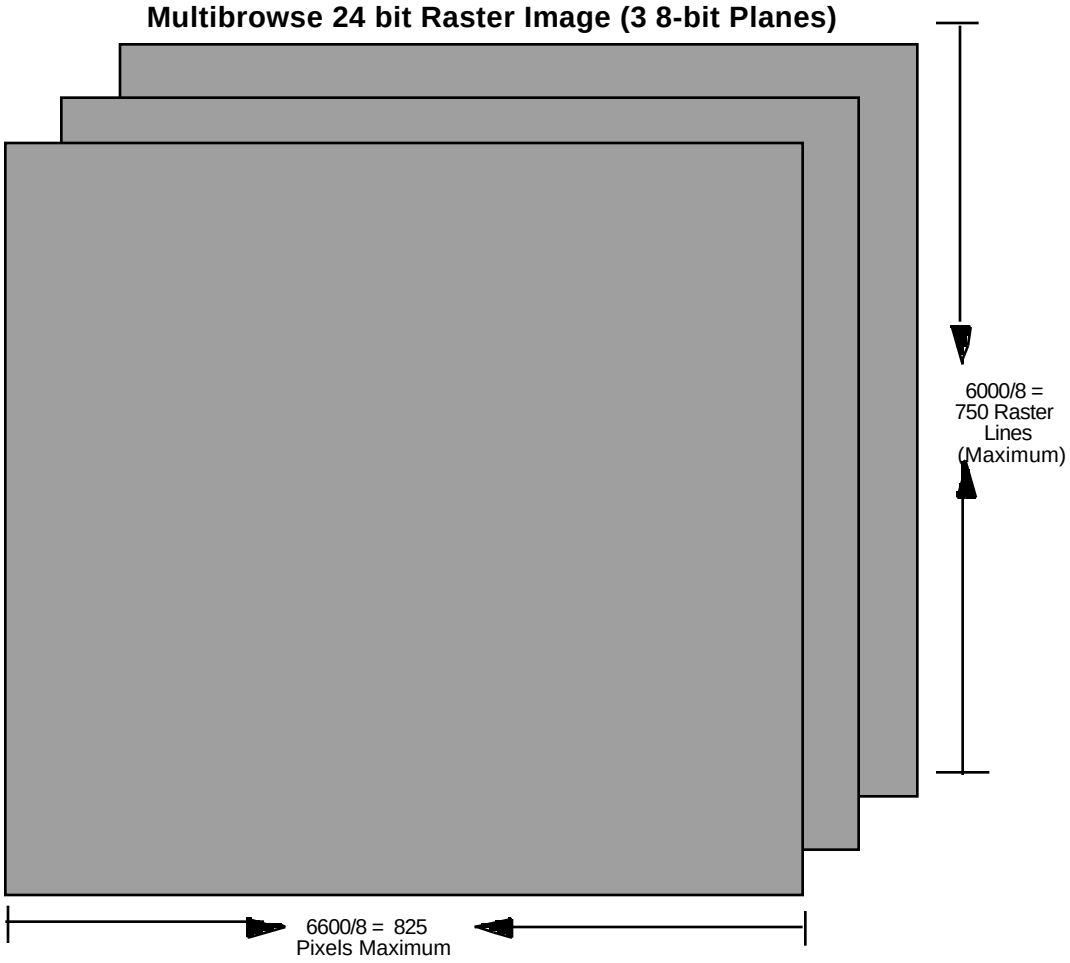
The LPS provides a multibrowse image for each of the WRS scenes identified in the metadata file for a Format 1 subinterval. The LPS multibrowse image, before its conversion to the HDF format, consists of three 8-bit reduced size images generated from three of the ETM+ Format 1 bands (1 through 5) selected by the operator. No multibrowse images are generated by LPS for ETM+ Format 2 bands (6, 7 and 8). This section describes and defines specific parameters for converting the LPS multibrowse output file to the HDF RIS format. Additional and reference information on the HDF formatted multibrowse image are provided in the HDF-EOS Primer for Version 1 EOSDIS (175-WP-001-001, April 1995).

4.3.1 Multi-browse File Overview

The LPS multibrowse output file (package) consists of a RIS24 image object and information for compressing the image and labelling it. The source multibrowse image consists of three 8 bit reduced size image planes (suitable for interleave by plane in HDF). All three image planes are of the same size and aspect ratio. The nominal size of these image planes depends on the size of the input band image and the subsampling and the wavelet run factors used in producing the multibrowse image in LPS. The LPS assumes/uses an input band image size of 6600 pixels X 6000 scans lines (maximum) for a full WRS scene and uses a subsampling factor of 2 (reduction by 4) with two Wavelet runs (another reduction by 16 (4x4)) for generating the multibrowse images. This results in a nominal size of 825 X 750 for the LPS output multibrowse image. Figure 4-4 provides an overview of the LPS output multibrowse image file. The LPS randomly chooses input band-detectors for generating multibrowse images. This selection allows LPS operators/users to review the quality of all Format 1 bands, if desired.

Note, if an input image size of 6967 x 5956, known to Landsat 4/5 users, is used with the same reduction factors, the LPS will produce a 871 X 746 size browse image. The LPS chosen image input image size of 6600 X 6000 is based on a nominal scan length of 6313 pixels plus a bumper wear allowance of 17 pixels, and an alignment margin of 270 pixels (minor frames). The maximum scene length of 355 scans for the input scene allows 20 extra scans to account for scene size variations/errors.

Tables 4-14, 15 and 16 contain specific definitions for the HDF RIS 24 parameters for generating the LPS multibrowse image objects and labels. No color palette is required for the HDF RIS24 object



Notes:
- Multibrowse ouput size: 1.86 MB (for 3 8-bit planes)
- reduction factor: 8 X 8 = 64
- Multibrowse output image is compressed to <= 1 MB using HDF/JPEG (Ratio ~ 50%) before transfer to LP DAAC
- The band image data aspect ratio is maintained in multi-browse and in JPEG output(TBD).

Figure 4-4: LPS Produced Multi-Browse Image File (Before HDF/JPEG Compression)

Table 4-14: Multi-browse File - HDF RIS24 Object Definition

HDF RIS24 File Definition Parameters	Remarks
RIS24 File Name: LXsssfnYYDOYHHuuv.xxx where; xxx = Rnn Where, nn = 01 - 99	**See Section 3.5 for LPS file naming convention.** Approximately nn = 35 multi-browse images are possible in a 14 minute subinterval.
Multibrowse Image Width = 825	Width = (Band Data Pixels+Fill)/8 For Bands, 1-5 and 7, (6330+270)/8 = 825 The nominal width of 6330 pixels in a scan line include 17 pixels due to scanner bumper wear).
Multibrowse Image Height = 750	Height = (Band Data Lines + 20)/8 For Bands, 1-5 and 7, 16x(355+20)/8 = 750
Interlace: by Plane	(Depth x Width x Height) where, Depth = 3 for a 3 band multibrowse image. Interleave by planes is recommended for LPS to keep each band data in a single plane under the HDF scheme. HDF utilities are available to read the multibrowse data from any one of the three RIS24 planes (one band of the three bands) in the RIS8 format.
Compression: JPEG (TBR)	
Compression Quality Factor: 50	To reduce the output multibrowse image size to under 1 MB.
Compression Baseline = 1	HDF required, set to ON =1 for JPEG
No. of Multibrowse images per RIS24 File = 1	One image object per HDF file to comply HDF limitation of 1 MB for LPS multibrowse files.

Table 4-15: Multibrowse RIS24 File Label and Description

RIS24 Object Annotation Information **** Multibrowse ASCII Text lines are shown in ** double quotes. Omit in HDF implementation.**	**Remarks**
RIS24 File Label: LXsssfnYYDOYHHuuv.xxx	Same as the RIS 24 File name shown above
RIS24 File Description:	***Add the following annotation lines to RIS24 File Description****
"Metadata File name: 7XsssfnYYDOYHHuuv.MTA"	Reference metadata file
"File Creation Date & Time:	
"File version:	

Table 4-16: Multibrowse RIS24 Object Label and Description

RIS24 Object Annotation Information **** Multibrowse ASCII Text lines are shown in ** double quotes. Omit in HDF implementation.**	**Remarks**
"RIS24 Image Object label: LXsssfnYYDOYHHuuv.xxx"	Same as File Label
RIS24 Object Description:	*****Add the following annotation lines to RIS24 Object Description******
"WRS Scene No.: nn"	where nn = 01 - 35 The WRS scene number in the metadata file associated with this multibrowse image. A maximum of 35 WRS scenes are expected in a 14. 1 minute long contact period/subinterval.
"WRS Scene Center Time: YY:ddd:hh:mm:ss.ttt"	The WRS scene center time determined by LPS
"Band IDs: BBB"	where each B is in the range 1-6. ETM+ Format 1 Bands used in generating the multibrowse image.
"Starting Detectors: AA, BB, CC"	where AA, BB and CC are Detector IDs in the range 01-16 The ETM+ band detector number used in to start the subsampling operation.
"Subsample Factor: S"	where S is 2, 4, or 8 The subsampling (number of detector/pixels to skip) scheme used in input data reduction. A factor of 2 reduces an input image to 1/4th; a factor of 4 reduces the input to its 1/16th, and so on. The LPS uses a subsample by 2 (1 run) in its multibrowse scheme.
"Wavelet Runs: W"	where W : 1-9 The number of Wavelet runs used to generate the multibrowse image. Each run reduces the input size to its 1/4th. The LPS uses 2 Wavelet runs in its multibrowse scheme.

4.3.3 Multi-browse File Format

Specific details on the HDF formatted multibrowse image are provided in the HDF-EOS Primer for Version 1 EOSDIS (175-WP-001-001, April 1995).

Appendix A - LPS Output Files Reference Information

This appendix contains the following reference information:

a. Landsat 7 ETM+ Band-Pixel Alignment Table (Sample - **TBR)**

b. PCD by Data Categories as identified in the Landsat 7 DFCB

c. PCD Locator by Data Item Name

d. PCD Positions in a PCD Cycle

Table A-1: Landsat 7 ETM+ Band-Pixel Alignment Table
(Not an LPS Output File - For LPS Reference Only)

		Forward Scan -->		<-- Reverse Scan	
Detectors	No. of Detectors	West End	East End	West End	East End
Band 1 Even	8	186	8	188	6
Band 1 Odd	8	183	11	186	8
Band 2 Even	8	161	33	163	31
Band 2 Odd	8	158	36	161	33
Band 3 Even	8	136	58	138	56
Band 3 Odd	8	133	61	136	58
Band 4 Even	8	111	83	113	81
Band 4 Odd	8	108	86	111	83
Band 5 Even	8	66	128	68	126
Band 5 Odd	8	63	131	66	128
Band 7 Even	8	40	154	42	152
Band 7 Odd	8	37	147	40	154
Band 6 1	4	0	194	7	187
Band 6 2	4	12	182	15	179
Band 6 3	4	1	193	6	188
Band 6 4	4	12	181	14	180
Band 8 (Pan) Even	16	TBD	TBD	TBD	TBD
Band 8 (Pan) Odd	16	TBD	TBD	TBD	TBD

Notes:
1. To correct for Detector Layout Geometry, Multiplexer Sampling and Delay Times.
2. Ref. Landsat 6 L0 CCT Format Document June 1990

3. The number of pixels (bytes) starting from each end are discarded (shifted out and/or filled) because they contain indeterminate values.

A-2: PCD by Data Categories as identified in the Landsat 7 DFCB

PCD Group	PCD Item	Size (Bytes)	MJFM No.	Begin mnfm	End mnfm	Begin Word	End Word
ADS (all minor frames)	ADS-X1	2	All	0	127	3	4
	ADS-Y1	2	All	0	127	5	6
	ADS-Z1	2	All	0	127	7	8
	ADS-X2	2	All	0	127	11	12
	ADS-Y2	2	All	0	127	13	14
	ADS-Z2	2	All	0	127	15	16
	ADS-X3	2	All	0	127	19	20
	ADS-Y3	2	All	0	127	21	21
	ADS-Z3	2	All	0	127	23	24
	ADS-X4	2	All	0	127	27	28
	ADS-Y4	2	All	0	127	29	30
	ADS-Z4	2	All	0	127	31	32
	ADS-X5	2	All	0	127	35	36
	ADS-Y5	2	All	0	127	37	38
	ADS-Z5	2	All	0	127	39	40
	ADS-X6	2	All	0	127	43	44
	ADS-Y6	2	All	0	127	45	46
	ADS-Z6	2	All	0	127	47	48
	ADS-X7	2	All	0	127	51	52
	ADS-Y7	2	All	0	127	53	54
	ADS-Z7	2	All	0	127	55	56
	ADS-X8	2	All	0	127	59	60
	ADS-Y8	2	All	0	127	61	62
	ADS-Z8	2	All	0	127	63	64
	ADS-X9	2	All	0	127	66	67
	ADS-Y9	2	All	0	127	68	69
	ADS-Z9	2	All	0	127	70	71
	ADS-X10	2	All	0	127	74	75

	ADS-Y10	2	All	0	127	76	77
	ADS-Z10	2	All	0	127	78	79
	ADS-X11	2	All	0	127	82	83
	ADS-Y11	2	All	0	127	84	85
	ADS-Z11	2	All	0	127	86	87
	ADS-X12	2	All	0	127	90	91
	ADS-Y12	2	All	0	127	92	93
	ADS-Z12	2	All	0	127	94	95
	ADS-X13	2	All	0	127	98	99
	ADS-Y13	2	All	0	127	100	101
	ADS-Z13	2	All	0	127	102	103
	ADS-X14	2	All	0	127	106	107
	ADS-Y14	2	All	0	127	108	109
	ADS-Z14	2	All	0	127	110	111
	ADS-X15	2	All	0	127	114	115
	ADS-Y15	2	All	0	127	116	117
	ADS-Z15	2	All	0	127	118	119
	ADS-X16	2	All	0	127	122	123
	ADS-Y16	2	All	0	127	124	125
	ADS-Z16	2	All	0	127	126	127
ADS Temperature	ADS-X Temp1	2	All	108	109	72	72
	ADS-Y Temp2	2	All	110	111	72	72
	ADS-Z Temp3	2	All	112	113	72	72
	ADS Elec. A/D Temp	2	All	114	115	72	72
ADS Temp Sample Time	ADS-X Temp1-Sample Time	1	All	108	108	71	71
	ADS-Y Temp2-Sample Time	1	All	110	110	71	71
	ADS-Z Temp3-Sample Time	1	All	112	112	71	71
	ADS Elec. A/D Temp-Sample Time	1	All	114	114	71	71

Gyro Data	IMU-XA (Roll)	3	All	0	0	81	& 97
(Repeated at 4 minor frame			All	1	1	17	17
interval till minor frame# 127)	IMU-YA (Pitch)	3	All	0	0	113	113
			All	1	1	33	& 49
	IMU-ZA (Yaw)	3	All	1	1	81	& 97
			All	1	1	113	113
	IMU-XB (Roll)	3	All	2	2	81	& 97
			All	3	3	17	17
	IMU-YB (Pitch)	3	All	2	2	113	113
			All	3	3	33	& 49
	IMU-ZB (Yaw)	3	All	3	3	81	& 97
			All	3	3	113	113
Gyro Drift Data	Theta-BX	4	0	16	19	72	72
	Theta-By	4	0	20	23	72	72
	Theta-BZ	4	0	24	27	72	72
Attitude Estimate	EPA1	4	All	0	3	72	72
	EPA2	4	All	4	7	72	72
	EPA3	4	All	8	11	72	72
	EPA4	4	All	12	15	72	72
Time of Last SV Clock Update	SV Clock Last Update Time	6	0	28	33	72	72
SV Clock Drift	Time Drift Bias (C0)	2	0	36	37	72	72
	Time Drift Rate (C2)	2	0	38	39	72	72
	Time Drift Acceleration (C2)	2	0	40	41	72	72
Ephemeris	Position Coordinate X	4	0 & 2	50	53	72	72
	Position Coordinate Y	4	0 & 2	54	57	72	72

	Position Coordinate Z	4	0 & 2	58	61	72	72
	Velocity Coordinate X	4	0 & 2	62	65	72	72
	Velocity Coordinate Y	4	0 & 2	66	69	72	72
	Velocity Coordinate Z	4	0 & 2	70	73	72	72
	Position Coordinate X	4	1 & 3	16	19	72	72
	Position Coordinate Y	4	1 & 3	20	23	72	72
	Position Coordinate Z	4	1 & 3	24	27	72	72
	Velocity Coordinate X	4	1 & 3	28	31	72	72
	Velocity Coordinate Y	4	1 & 3	32	35	72	72
	Velocity Coordinate Z	4	1 & 3	36	39	72	72
ETM+ TLM /16.384 seconds	ETM TLM MF(2) mfs(16-30)	15	2	16	30	72	72
	Serial Word "A"	1	2	31	31	72	72
	Serial Word "B"	1	2	32	32	72	72
	Serial Word "C"	1	2	33	33	72	72
	Serial Word "D"	1	2	34	34	72	72
	Serial Word "E"	1	2	35	35	72	72
	Serial Word "F"	1	2	36	36	72	72
	Serial Word "G"	1	2	37	37	72	72
	Serial Word "H"	1	2	38	38	72	72
	Serial Word "I"	1	2	39	39	72	72
	ETM TLM MF(2) mfs(40-49)	10	2	40	49	72	72
ETM+ TLM / 4.096 seconds	Black Body Temperature (Isolated)	1	All	74	74	72	72
	CFPA Heater Current	1	All	75	75	72	72
	Calibration Shutter Flag Temperature	1	All	76	76	72	72
	Backup Shutter Flag Temperature	1	All	77	77	72	72

	Black Body Temperature (Control)	1	All	78	78	72	72
	Baffle Temperature (Heater)	1	All	79	79	72	72
	CFPA Control Temperature	1	All	80	80	72	72
	Mux 1 Electronics Temperature	1	0	81	81	72	72
	Mux 1 Power Supply Temperature	1	0	82	82	72	72
	Mux 2 Electronics Temperature	1	0	83	83	72	72
	Mux 2 Power Supply Temperature	1	1	81	81	72	72
	Serial Word "J"	1	1	82	82	72	72
	Serial Word "K"	1	1	83	83	72	72
	Serial Word "L"	1	2	81	81	72	72
	Serial Word "M"	1	2	82	82	72	72
	Serial Word "N"	1	2	83	83	72	72
	Serial Word "P"	1	2	84	84	72	72
	Serial Word "Q"	1	3	81	81	72	72
	Serial Word "R"	1	3	82	82	72	72
	Serial Word "S"	1	3	83	83	72	72
	ACS CPU Mode	1	3	84	84	72	72
Spacecraft ID	Spacecraft ID (ASCII)	1	0	96	96	72	72
Timecode (PCD Reference Time)	Timecode	7	0	96	102	72	72
PDF A/D Ground Reference	PDF A/D Ground Reference	2	All	116	117	72	72

Minor Frame Sync	Minor Frame Sync	3	All	0	127	0	2
Minor Frame ID	Minor Frame ID	1	All	0	127	65	65
Major Frame Identification	MJFM ID "0" = (S/C ID & Time)	7	0	96	103	72	72
	MJFM ID "1"	8	1	96	103	72	72
	MJFM ID "2"	8	2	96	103	72	72
	MJFM ID "3"	8	3	96	103	72	72
ETM+ On/Off Times	ETM+ On Time	6	0	42	47	72	72
	ETM+ Off Time	6	0	84	89	72	72

Table A-3: PCD Locator by Data Item Name

PCD Item	Size (Bytes)	MJFM No.	Begin mnfm	End mnfm	Begin Word	End Word
ACS CPU Mode	1	MF3	84	84	72	72
ADS Elec. A/D Temp	2	All	114	115	72	72
ADS Elec. A/D Temp-Sample Time	1	All	114	114	71	71
ADS-X Temp1	2	All	108	109	72	72
ADS-X Temp1-Sample Time	1	All	108	108	71	71
ADS-X1	2	All	0	127	3	4
ADS-X10	2	All	0	127	74	75
ADS-X11	2	All	0	127	82	83
ADS-X12	2	All	0	127	90	91
ADS-X13	2	All	0	127	98	99
ADS-X14	2	All	0	127	106	107
ADS-X15	2	All	0	127	114	115
ADS-X16	2	All	0	127	122	123
ADS-X2	2	All	0	127	11	12
ADS-X3	2	All	0	127	19	20
ADS-X4	2	All	0	127	27	28
ADS-X5	2	All	0	127	35	36
ADS-X6	2	All	0	127	43	44
ADS-X7	2	All	0	127	51	52
ADS-X8	2	All	0	127	59	60
ADS-X9	2	All	0	127	66	67
ADS-Y Temp2	2	All	110	111	72	72
ADS-Y Temp2-Sample Time	1	All	110	110	71	71
ADS-Y1	2	All	0	127	5	6
ADS-Y10	2	All	0	127	76	77
ADS-Y11	2	All	0	127	84	85
ADS-Y12	2	All	0	127	92	93
ADS-Y13	2	All	0	127	100	101
ADS-Y14	2	All	0	127	108	109
ADS-Y15	2	All	0	127	116	117

ADS-Y16	2	All	0	127	124	125
ADS-Y2	2	All	0	127	13	14
ADS-Y3	2	All	0	127	21	21
ADS-Y4	2	All	0	127	29	30
ADS-Y5	2	All	0	127	37	38
ADS-Y6	2	All	0	127	45	46
ADS-Y7	2	All	0	127	53	54
ADS-Y8	2	All	0	127	61	62
ADS-Y9	2	All	0	127	68	69
ADS-Z Temp3	2	All	112	113	72	72
ADS-Z Temp3-Sample Time	1	All	112	112	71	71
ADS-Z1	2	All	0	127	7	8
ADS-Z10	2	All	0	127	78	79
ADS-Z11	2	All	0	127	86	87
ADS-Z12	2	All	0	127	94	95
ADS-Z13	2	All	0	127	102	103
ADS-Z14	2	All	0	127	110	111
ADS-Z15	2	All	0	127	118	119
ADS-Z16	2	All	0	127	126	127
ADS-Z2	2	All	0	127	15	16
ADS-Z3	2	All	0	127	23	24
ADS-Z4	2	All	0	127	31	32
ADS-Z5	2	All	0	127	39	40
ADS-Z6	2	All	0	127	47	48
ADS-Z7	2	All	0	127	55	56
ADS-Z8	2	All	0	127	63	64
ADS-Z9	2	All	0	127	70	71
Backup Shutter Flag Temperature	1	All	77	77	72	72
Baffle Temperature (Heater)	1	All	79	79	72	72
Black Body Temperature (Control)	1	All	78	78	72	72
Black Body Temperature (Isolated)	1	All	74	74	72	72
Calibration Shutter Flag Temperature	1	All	76	76	72	72
CFPA Control Temperature	1	All	80	80	72	72
CFPA Heater Current	1	All	75	75	72	72

EPA1	4	All	0	3	72	72
EPA2	4	All	4	7	72	72
EPA3	4	All	8	11	72	72
EPA4	4	All	12	15	72	72
ETM TLM MF(2) mfs(16-30)	15	MF2	16	30	72	72
ETM TLM MF(2) mfs(40-49)	10	MF2	40	49	72	72
ETM+ Off Time	6	MF0	84	89	72	72
ETM+ On Time	6	MF0	42	47	72	72
Gyro Select Data	1	MF0	34	34	72	72
IMU-XA (Roll)	2	All	0	0	81	& 97
IMU-XA (Roll)	1	All	1	1	17	17
IMU-XB (Roll)	2	All	2	2	81	& 97
IMU-XB (Roll)	1	All	3	3	17	17
IMU-YA (Pitch)	2	All	0	0	113	113
IMU-YA (Pitch)	1	All	1	1	33	& 49
IMU-YB (Pitch)	2	All	2	2	113	113
IMU-YB (Pitch)	1	All	3	3	33	& 49
IMU-ZA (Yaw)	2	All	1	1	81	& 97
IMU-ZA (Yaw)	1	All	1	1	113	113
IMU-ZB (Yaw)	2	All	3	3	81	& 97
IMU-ZB (Yaw)	1	All	3	3	113	113
Minor Frame ID	1	All	0	127	65	65
Minor Frame Sync	3	All	0	127	0	2
MJFM ID "0" = (S/C ID & Time)	7	MF0	96	103	72	72
MJFM ID "1"	8	MF1	96	103	72	72
MJFM ID "2"	8	MF2	96	103	72	72
MJFM ID "3"	8	MF3	96	103	72	72
Mux 1 Electronics Temperature	1	MF0	81	81	72	72
Mux 1 Power Supply Temperature	1	MF0	82	82	72	72
Mux 2 Electronics Temperature	1	MF0	83	83	72	72
Mux 2 Power Supply Temperature	1	MF1	81	81	72	72
PDF A/D Ground Reference	2	All	116	117	72	72
Position Coordinate X	4	MF0	50	53	72	72
Position Coordinate X	4	MF1	16	19	72	72

Position Coordinate X	4	MF2	50	53	72	72
Position Coordinate X	4	MF3	16	19	72	72
Position Coordinate Y	4	MF0	54	57	72	72
Position Coordinate Y	4	MF1	20	23	72	72
Position Coordinate Y	4	MF2	54	57	72	72
Position Coordinate Y	4	MF3	20	23	72	72
Position Coordinate Z	4	MF0	58	61	72	72
Position Coordinate Z	4	MF1	24	27	72	72
Position Coordinate Z	4	MF2	58	61	72	72
Position Coordinate Z	4	MF3	24	27	72	72
Serial Word "A"	1	MF2	31	31	72	72
Serial Word "B"	1	MF2	32	32	72	72
Serial Word "C"	1	MF2	33	33	72	72
Serial Word "D"	1	MF2	34	34	72	72
Serial Word "E"	1	MF2	35	35	72	72
Serial Word "F"	1	MF2	36	36	72	72
Serial Word "G"	1	MF2	37	37	72	72
Serial Word "H"	1	MF2	38	38	72	72
Serial Word "I"	1	MF2	39	39	72	72
Serial Word "J"	1	MF1	82	82	72	72
Serial Word "K"	1	MF1	83	83	72	72
Serial Word "L"	1	MF2	81	81	72	72
Serial Word "M"	1	MF2	82	82	72	72
Serial Word "N"	1	MF2	83	83	72	72
Serial Word "P"	1	MF2	84	84	72	72
Serial Word "Q"	1	MF3	81	81	72	72
Serial Word "R"	1	MF3	82	82	72	72
Serial Word "S"	1	MF3	83	83	72	72
Spacecraft ID (ASCII)	1	MF0	96	96	72	72
SV Clock Last Update Time	6	MF0	28	33	72	72
Theta-BX	4	MF0	16	19	72	72
Theta-By	4	MF0	20	23	72	72
Theta-BZ	4	MF0	24	27	72	72
Time Drift Acceleration (C2)	2	MF0	40	41	72	72

Time Drift Bias (C0)	2	MF0	36	37	72	72
Time Drift Rate (C2)	2	MF0	38	39	72	72
Timecode	7	MF0	96	102	72	72
Velocity Coordinate X	4	MF0	62	65	72	72
Velocity Coordinate X	4	MF1	28	31	72	72
Velocity Coordinate X	4	MF2	62	65	72	72
Velocity Coordinate X	4	MF3	28	31	72	72
Velocity Coordinate Y	4	MF0	66	69	72	72
Velocity Coordinate Y	4	MF1	32	35	72	72
Velocity Coordinate Y	4	MF2	66	69	72	72
Velocity Coordinate Y	4	MF3	32	35	72	72
Velocity Coordinate Z	4	MF0	70	73	72	72
Velocity Coordinate Z	4	MF1	36	39	72	72
Velocity Coordinate Z	4	MF2	70	73	72	72
Velocity Coordinate Z	4	MF3	36	39	72	72

Table A-4: PCD Positions in a PCD Cycle

PCD Item	Size (Bytes)	MJFM No.	Begin mnfm	End mnfm	Begin Word	End Word
Minor Frame Sync	3	All	0	127	0	2
ADS-X1	2	All	0	127	3	4
ADS-Y1	2	All	0	127	5	6
ADS-Z1	2	All	0	127	7	8
ADS-X2	2	All	0	127	11	12
ADS-Y2	2	All	0	127	13	14
ADS-Z2	2	All	0	127	15	16
ADS-X3	2	All	0	127	19	20
ADS-Y3	2	All	0	127	21	21
ADS-Z3	2	All	0	127	23	24
ADS-X4	2	All	0	127	27	28
ADS-Y4	2	All	0	127	29	30
ADS-Z4	2	All	0	127	31	32
ADS-X5	2	All	0	127	35	36
ADS-Y5	2	All	0	127	37	38
ADS-Z5	2	All	0	127	39	40
ADS-X6	2	All	0	127	43	44
ADS-Y6	2	All	0	127	45	46
ADS-Z6	2	All	0	127	47	48
ADS-X7	2	All	0	127	51	52
ADS-Y7	2	All	0	127	53	54
ADS-Z7	2	All	0	127	55	56
ADS-X8	2	All	0	127	59	60
ADS-Y8	2	All	0	127	61	62
ADS-Z8	2	All	0	127	63	64
Minor Frame ID	1	All	0	127	65	65
ADS-X9	2	All	0	127	66	67
ADS-Y9	2	All	0	127	68	69
ADS-Z9	2	All	0	127	70	71
EPA1	4	All	0	3	72	72

ADS-X10	2	All	0	127	74	75
ADS-Y10	2	All	0	127	76	77
ADS-Z10	2	All	0	127	78	79
IMU-XA (Roll)	2	All	0	0	81	& 97
ADS-X11	2	All	0	127	82	83
ADS-Y11	2	All	0	127	84	85
ADS-Z11	2	All	0	127	86	87
ADS-X12	2	All	0	127	90	91
ADS-Y12	2	All	0	127	92	93
ADS-Z12	2	All	0	127	94	95
ADS-X13	2	All	0	127	98	99
ADS-Y13	2	All	0	127	100	101
ADS-Z13	2	All	0	127	102	103
ADS-X14	2	All	0	127	106	107
ADS-Y14	2	All	0	127	108	109
ADS-Z14	2	All	0	127	110	111
IMU-YA (Pitch)	2	All	0	0	113	113
ADS-X15	2	All	0	127	114	115
ADS-Y15	2	All	0	127	116	117
ADS-Z15	2	All	0	127	118	119
ADS-X16	2	All	0	127	122	123
ADS-Y16	2	All	0	127	124	125
ADS-Z16	2	All	0	127	126	127
IMU-XA (Roll)	1	All	1	1	17	17
IMU-YA (Pitch)	1	All	1	1	33	& 49
IMU-ZA (Yaw)	2	All	1	1	81	& 97
IMU-ZA (Yaw)	1	All	1	1	113	113
IMU-XB (Roll)	2	All	2	2	81	& 97
IMU-YB (Pitch)	2	All	2	2	113	113
IMU-XB (Roll)	1	All	3	3	17	17
IMU-YB (Pitch)	1	All	3	3	33	& 49
IMU-ZB (Yaw)	2	All	3	3	81	& 97
IMU-ZB (Yaw)	1	All	3	3	113	113
EPA2	4	All	4	7	72	72

EPA3	4	All	8	11	72	72
EPA4	4	All	12	15	72	72
Black Body Temperature (Isolated)	1	All	74	74	72	72
CFPA Heater Current	1	All	75	75	72	72
Calibration Shutter Flag Temperature	1	All	76	76	72	72
Backup Shutter Flag Temperature	1	All	77	77	72	72
Black Body Temperature (Control)	1	All	78	78	72	72
Baffle Temperature (Heater)	1	All	79	79	72	72
CFPA Control Temperature	1	All	80	80	72	72
ADS-X Temp1-Sample Time	1	All	108	108	71	71
ADS-X Temp1	2	All	108	109	72	72
ADS-Y Temp2-Sample Time	1	All	110	110	71	71
ADS-Y Temp2	2	All	110	111	72	72
ADS-Z Temp3-Sample Time	1	All	112	112	71	71
ADS-Z Temp3	2	All	112	113	72	72
ADS Elec. A/D Temp-Sample Time	1	All	114	114	71	71
ADS Elec. A/D Temp	2	All	114	115	72	72
PDF A/D Ground Reference	2	All	116	117	72	72
Theta-BX	4	MF0	16	19	72	72
Theta-By	4	MF0	20	23	72	72
Theta-BZ	4	MF0	24	27	72	72
SV Clock Last Update Time	6	MF0	28	33	72	72
Time Drift Bias (C0)	2	MF0	36	37	72	72
Time Drift Rate (C2)	2	MF0	38	39	72	72
Time Drift Acceleration (C2)	2	MF0	40	41	72	72
ETM+ On Time	6	MF0	42	47	72	72
Position Coordinate X	4	MF0	50	53	72	72
Position Coordinate Y	4	MF0	54	57	72	72
Position Coordinate Z	4	MF0	58	61	72	72
Velocity Coordinate X	4	MF0	62	65	72	72
Velocity Coordinate Y	4	MF0	66	69	72	72
Velocity Coordinate Z	4	MF0	70	73	72	72
Mux 1 Electronics Temperature	1	MF0	81	81	72	72
Mux 1 Power Supply Temperature	1	MF0	82	82	72	72

Mux 2 Electronics Temperature	1	MF0	83	83	72	72
ETM+ Off Time	6	MF0	84	89	72	72
MJFM ID "0" = (S/C ID & Time)	7	MF0	96	103	72	72
Spacecraft ID (ASCII)	1	MF0	96	96	72	72
Timecode	7	MF0	96	102	72	72
Position Coordinate X	4	MF1	16	19	72	72
Position Coordinate Y	4	MF1	20	23	72	72
Position Coordinate Z	4	MF1	24	27	72	72
Velocity Coordinate X	4	MF1	28	31	72	72
Velocity Coordinate Y	4	MF1	32	35	72	72
Velocity Coordinate Z	4	MF1	36	39	72	72
Mux 2 Power Supply Temperature	1	MF1	81	81	72	72
Serial Word "J"	1	MF1	82	82	72	72
Serial Word "K"	1	MF1	83	83	72	72
MJFM ID "1"	8	MF1	96	103	72	72
ETM TLM MF(2) mfs(16-30)	15	MF2	16	30	72	72
Serial Word "A"	1	MF2	31	31	72	72
Serial Word "B"	1	MF2	32	32	72	72
Serial Word "C"	1	MF2	33	33	72	72
Serial Word "D"	1	MF2	34	34	72	72
Serial Word "E"	1	MF2	35	35	72	72
Serial Word "F"	1	MF2	36	36	72	72
Serial Word "G"	1	MF2	37	37	72	72
Serial Word "H"	1	MF2	38	38	72	72
Serial Word "I"	1	MF2	39	39	72	72
ETM TLM MF(2) mfs(40-49)	10	MF2	40	49	72	72
Position Coordinate X	4	MF2	50	53	72	72
Position Coordinate Y	4	MF2	54	57	72	72
Position Coordinate Z	4	MF2	58	61	72	72
Velocity Coordinate X	4	MF2	62	65	72	72
Velocity Coordinate Y	4	MF2	66	69	72	72
Velocity Coordinate Z	4	MF2	70	73	72	72
Serial Word "L"	1	MF2	81	81	72	72
Serial Word "M"	1	MF2	82	82	72	72

Serial Word "N"	1	MF2	83	83	72	72
Serial Word "P"	1	MF2	84	84	72	72
MJFM ID "2"	8	MF2	96	103	72	72
Position Coordinate X	4	MF3	16	19	72	72
Position Coordinate Y	4	MF3	20	23	72	72
Position Coordinate Z	4	MF3	24	27	72	72
Velocity Coordinate X	4	MF3	28	31	72	72
Velocity Coordinate Y	4	MF3	32	35	72	72
Velocity Coordinate Z	4	MF3	36	39	72	72
Serial Word "Q"	1	MF3	81	81	72	72
Serial Word "R"	1	MF3	82	82	72	72
Serial Word "S"	1	MF3	83	83	72	72
ACS CPU Mode	1	MF3	84	84	72	72
MJFM ID "3"	8	MF3	96	103	72	72

Acronym List

AOS	Acquisition of Signal
BER	Bit Error Rate
CCB	Configuration Control Board
CCSDS	Consultative Committee on Space Data System
DCN	Document Change Notice
EDC	EROS Data Center
EROS	Earth Resources Observation System
ETM+	Enhanced Thematic Mapper plus
F&PS	Functional and Performance Specification
GSFC	Goddard Space Flight Center
ICD	Interface Control Document
LAN	Local area network
LP DAAC	Land Processes Distributed Active Archive Center
LPS	Landsat 7 Data Processing System
MOC	Mission Operations Center
MO&DSD	Mission Operations and Data Systems Directorate
NASA	National Aeronautics and Space Administration
UTC	Universal Time Code